PUBLIC WORKS

Mar.
1960

CITY, COUNTY AND STATE

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County Provides
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For All Articles
In This Issue

John C. Lilly is City Manager of Stockton, California. The rapid growth of the Stockton area has necessitated a very large public works improvement program under his direction. Details on page 26.

You can do A LOT OF... PROFITABLE JOBS with a GALION

GALION MOTOR GRADERS ARE THE MOST USEFUL UNITS OF CONSTRUCTION EQUIPMENT EVER BUILT

That's why it pays to own Galions.

- Rough grading
- Fine grading
- Windrowing
- Bank cutting
- Shoulder sloping
- Ditching
- Back-filling
- Spreading material
- Mix-in-place
- Scarifying
- Bulldozing
- Casting and Loading
- Snow removal
- and many others.

Write for the booklet, "How to Operate a Galion Motor Grader."

THE GALION IRON WORKS & MFG. CO.
General and Export Offices—Galion, Ohio, U.S.A.

GALION
ESTABLISHED 1907

MOTOR GRADERS & ROLLERS

"from Chicago"

A development of 25 years of sludge pumping experience...

THE NEW

SCRU-FLO

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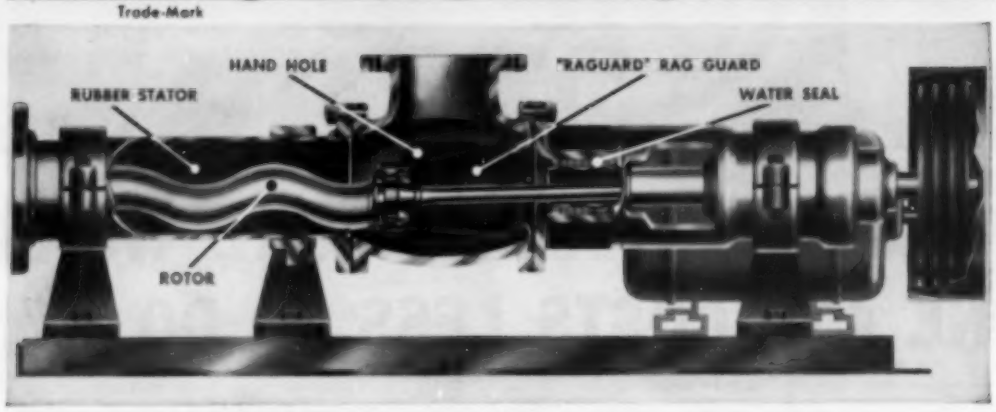

Screw Conveyor Clog Proof Sludge Pump

BETTER...here's why:

- Rotary, positive displacement pumping
- "RAGUARD"—"Chicago's" special shaft rag guard
- Low Speed operation
- Convenient Suction Clean-out openings
- Durometer 60 hardness BUNA-N RUBBER STATOR
- Hardened, Chrome-Steel Rotor
- Ample Reserve Motor Horsepower

For:

- **Primary sludge pumping**
- **Secondary sludge transfer**
- **Digester sludge recirculation**
- **Elutriated and concentrated sludge pumping**
- **Digester heat exchanger pumping**

Sizes: **For pumping sludges from 75 G.P.M. to 400 G.P.M. . . . at a 120' head**

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Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Chicago Pump Company

622H DIVERSEY PARKWAY • CHICAGO 14, ILLINOIS

1960 — 51 YEARS — CHICAGO PUMP COMPANY — 1909

J. F. FREEMAN, SUPT. AND WARDEN
OF SUMTER COUNTY, GA., REPORTS:

"CAT EQUIPMENT GETS MORE WORK DONE AND COSTS LESS TO DO IT"

Construction and grading of Lamar Road, four miles east of Americus in Sumter County, Georgia, gave county officials an opportunity to discuss their methods and machinery in county road construction.

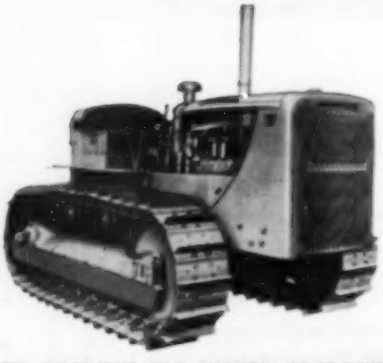
At work on the grading were three tractor-scraper combinations: a D7 Tractor and No. 435 Scraper and two D7s with No. 70 Scrapers. (Sumter County also owns two Cat D6 Tractors and four Cat Motor Graders.)

"Our Caterpillar road building machinery has always given us mighty satisfactory service," said J. F. Freeman, Superintendent and Warden of Sumter County. "My observation over the years is that it gets more work done and costs less to do it."

Getting the work done economically has long been routine for Caterpillar track-type Tractors and Scrapers; this combination of traction and capacity has been the backbone of many efficient dirt-moving spreads. They're the economy masters of the short hauls and the rough ground conditions. Track-type tractors and four-wheel scrapers are naturals for steep grades, rough rocky ground and mud. Conditions that would sideline rubber-tired tractors, or short hauls that would make the high-speed units uneconomical are easy jobs for crawlers.

Your Caterpillar Dealer has production information on a full line of crawler tractors and four-wheel scrapers. He has the equipment to fit *your* dirt-moving job. Ask for a demonstration.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.



A NEW PRODUCT FOR HIGHER PRODUCTION!

Cat D7 Series D Tractor By any comparison the new Cat D7 Series D Tractor is champ in its class. It packs 140 horsepower... matched with 80% more lugging ability than the previous model. And it delivers this production with lower operating and maintenance cost. Here is performance that no other tractor in its power range can match.

CATERPILLAR

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BORN OF RESEARCH
PROVED IN THE FIELD

PUBLIC WORKS

THE MOST USEFUL ENGINEERING MAGAZINE FOR CITIES, COUNTIES AND STATE

MARCH, 1960 • Volume 91, Number 3

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Satisfactory results of three years operation show that this treatment method is effective and economical. WILLIAM E. GERMAN

The Use of Epoxy Resins on the New Jersey Turnpike 98
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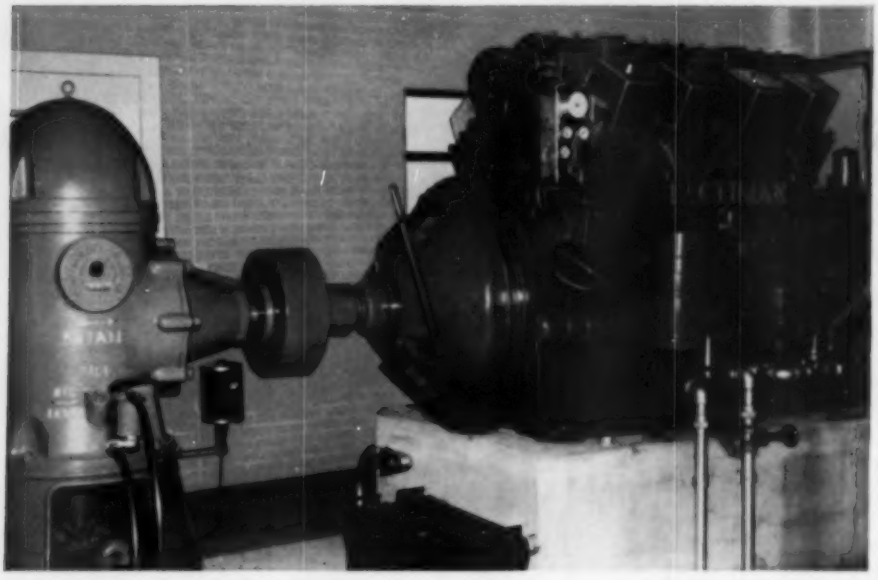
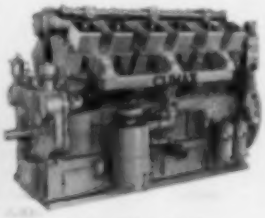
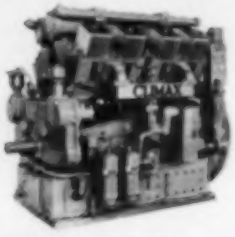
200 So. Broad St., Ridgewood, N. J.

CLIMAX MUNICIPAL ENGINES

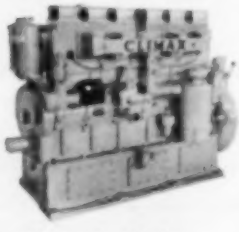




V-125—12 cylinder,
605 max. hp. at 1200 rpm.
V-122—12 cylinder,
520 max. hp. at 1200 rpm.



V-85—8 cylinder,
390 max. hp. at 1200 rpm.
V-80—8 cylinder,
340 max. hp. at 1200 rpm.



K-75—6 cylinder,
304 max. hp. at 1200 rpm.
K-67—6 cylinder,
265 max. hp. at 1200 rpm.

IN SEWAGE TREATMENT PLANTS everywhere Climax engines power sewage pumps, blowers and generators. Burning sludge gas, and utilizing heat from jacket water and engine exhaust gas to heat digesters and buildings, they effect big savings. Capable of operation on natural gas, butane, gasoline, or any combination. For continuous duty service in sewage plants—eight rugged Climax models: 12, 8, 6, 4 cylinders.

IN WATER WORKS over 100 cities depend on Climax engines... for prime power, or to take over when normal power for pumps is interrupted or fails . . . and to drive pumps during peak loads as supplementary power. Burning natural gas, butane or gasoline Climax Water Works engines range in size to 600 hp.

Write direct for bulletins, specifications and engineering consultation.

CL-106

BASIC MAX. ENGINE HP (Natural Gas and Gasoline) ①					600	700	800	900	1000	1100	1200
MODEL	No. of Cyls.	Bore & Stroke	Displ.	Torque @ RPM	BRAKE HORSEPOWER AT SPEEDS INDICATED						
R-110	4	6⅛ x 7	824	610 @ 800	68	83	94	105	115	123	125
R-165	6	6⅛ x 7	1238	930 @ 750	105	123	140	156	170	183	192
K-67	6	7 x 7	1616	1240 @ 805	140	165	188	210	230	248	265
K-75	6	7½ x 7	1855	1410 @ 800	160	186	214	240	265	286	304
V-80	8	7 x 7	2155	1610 @ 850	178	210	241	272	300	323	340
V-85	8	7½ x 7	2474	1860 @ 900	207	249	285	317	345	370	390
V-122	12	7 x 7	3232	2440 @ 900	280	330	380	420	460	490	520
V-125	12	7½ x 7	3711	2880 @ 850	310	370	435	490	540	580	605

① Basic engine includes ignition, maximum carburetion, and water pump. Ratings indicate maximum horsepower.

CLIMAX ENGINE MANUFACTURING CO. • FACTORY—CLINTON, IOWA
DIVISION OF WAUKESHA MOTOR COMPANY

Labor Saving and Cost Reduction in Highway Maintenance

JUST AS SOON as construction of a highway is completed, maintenance begins. Generally speaking, the better the highway, the more it costs to maintain. A good surface may reduce markedly the cost of keeping the traveled way in good condition; but such a highway type brings on other costs—bridge and culvert maintenance, roadside vegetation, drainage structures and signs, to mention only a few items. Secondary roads will also need resurfacing, patching, and shoulder and ditch maintenance.

The day is past when any community or jurisdiction can afford to use other than the most modern labor saving equipment for such work. One reason is the cost; another is traffic interference. We believe there is need for a serious study of the problems of maintenance, including equipment now available and that which may be needed. Such a study should include also the methods for best utilizing existing equipment—as by teams, trains or task units specially equipped for the job.

Automobile production will increase and with it road mileage. As mileage and traffic grow, so will the need for more efficient means of maintenance. Compared to design and construction, research on maintenance has been deficient.

The Metropolitan Ring—Its Growth and Problems

IT IS ESTIMATED that, in the next 20 years, metropolitan area population will have increased by 80 million over the 1950 population. Of this, 64 million or 80 percent will be in the suburban areas, and 16 million or 20 percent in existing cities proper. Of the 64 million in the suburban ring, 35 million or more than 60 percent will go into unincorporated areas. This situation will pose a real problem in public works, but probably most in the sewerage and refuse areas. It can be expected that satisfactory water can be supplied to most of this 35 million; paving and storm drainage will be costly but the necessity for providing at least street surfacing as an aid in selling homes will tend to resolve these phases.

For a satisfactory solution to the waste disposal problems, a new realism on the part of health departments and county governing bodies will be needed; also a new approach to the responsibilities of county government.

If there are to be 10 persons per gross acre of area, these probable 35 million of unincorporated area residents will require an unbelievable mileage of streets, sewers, water mains and refuse collection routes. Try figuring it out for yourself.

That Third Dimension in Engineering

THE AIR HAS long provided a big help in engineering through faster and cheaper mapping and more rapid transportation. Now cities can have their own air equipment, useful in many ways, through the cooperation of the office of Civil Defense which, under certain conditions, will pay up to half the cost for a helicopter. Such a machine can be a big asset in solving traffic control problems, getting that quick first-hand look at terrain from the air and transporting men and engineering equipment to distant or difficult places, to mention a few jobs. Getting the engineer off the ground will do much to speed up his work while often providing sounder bases on which to make decisions.

Industry Should Learn to Use Less Water and Create Less Pollution

IT SEEMS probable that the vast amounts of water now being used by industry could be reduced materially if adequate research on the water use problem were initiated and carried on vigorously. Such reduction in overall water use will be essential in many areas if our present projections of future water consumption are correct. It is not so much a problem of cost of water as it is a matter of the available supply which must be allocated to various uses.

Another area where industry research is desirable lies in the possibility of substitution, for some of the chemicals now used, of others which will impose a smaller organic loading on our streams or which will be easier to treat by standard methods.

Some progress has been made in both fields, but generally this has been sporadic and limited to a few industrial plants where more or less painful problems have existed. A much broader approach and on a sounder long range basis is needed now and will be essential in the future.

THE MARK OF THE 100-YEAR PIPE

PERMANENTLY YOURS: CAST IRON PIPE

Installed... it stays installed

One thing sure about cast iron pipe—once it's in the ground, it's there for keeps! Over 100 American utilities, having used cast iron pipe steadily for more than a century, can testify to that. And *modern* cast iron pipe gives you greater assurance than ever: great beam strength resists heavy surface traffic; tremendous load resistance absorbs even the most forceful pressures. In fact, when you select cast iron pipe, you can anticipate no major repairs in your water supply system for the next hundred years!

Cement-lined—it stays cement-lined

A smooth coat of cement lining along the inner wall helps prevent the formation of flow-reducing particles. No matter how strong the water is, cast iron pipe always assures a free, steady flow.

Joined—it stays joined

Bottle-tight, rubber-ring joints give you leak-proof protection at the most vulnerable points of your system. Vibrations, surface traffic and washouts present no problem to cast iron pipe. Inherent ruggedness . . . built to perform under all adverse underground conditions . . . repair-free service for at least a century—all good reasons why your choice should be that of water utility experts everywhere. America's greatest water carrier: cast iron pipe.

Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 3440 Prudential Plaza, Chicago 1, Illinois

CAST IRON PIPE

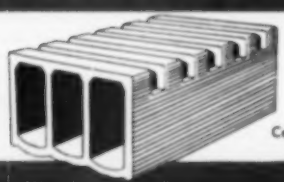
Everyone can't live upstream, but....

DOWNSTREAM can be made safe, too!

4 large trickling filters, Trinity River Authority, West Dallas, Texas. *Engineers:* Forrest and Cotton, Dallas. *Contractors:* H. F. Allison Co. & Wylie Bros.

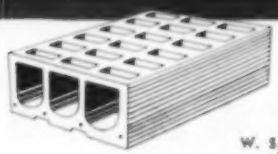
New Handbook Now Being Distributed

Mr. City Engineer and Mr. Consultant! If you haven't received your free copy of the new data-filled TFFI Handbook on Trickling Filters, which contains latest ASTM Specifications for vitrified clay underdrain blocks, write for a copy. Send your request to the nearest member firm.



TRANSLOT
Connelton Sewer Pipe Co.
Connelton, Ind.

TFFI Trickling



DICKEY
W. S. Dickey Clay Mfg. Co.
Kansas City 6, Mo.

Clean waters for boating and fishing, too, follow use of trickling filters for sewage treatment.

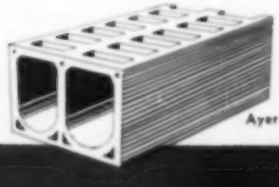
Photo courtesy of Johnson Motors.

Dumping raw or inadequately created sewage into streams which are downstream communities' source of water supply is of necessity coming to an end. Anticipate now their demands for protection from your sewage and industrial wastes by building trickling filters.

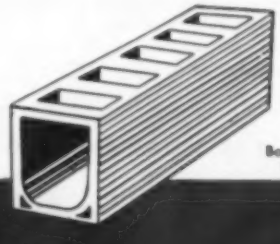
Trickling filters for treating these wastes are the average community's best answer. Properly designed, they provide clean waters for downstream neighbors with maximum efficiency and economy. And when equipped with TFFI Specification vitrified clay underdrain blocks they insure permanence and trouble-free performace. Only vitrified clay can free you from future ravages of acids, alkalis and bacterial action, as well as the danger of costly replacements.

50-YEAR GUARANTEE

An exclusive TFFI feature is every manufacturer member's guarantee that their blocks will withstand every common corrosive and disintegrant force for at least 50 years. TFFI blocks are made in modern plants under rigid controls of quality that no substitute material can even approach. This makes such a guarantee possible.

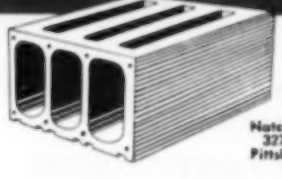


ARMCRE
Ayer-McCarel Clay Co., Inc.
Brazil, Ind.



BOSCO
Bowerston Shale Co.
Bowerston, Ohio

Filter Floor Institute



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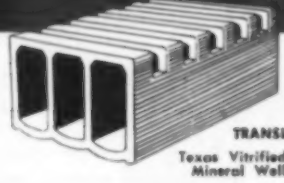
Natco Corporation
327 Fifth Ave.
Pittsburgh 22, Pa.

POMONA
Pomona Terra-Cotta Co.
Greensboro, No. Car.



TRANSLOT
Texas Vitrified Pipe Co.
Mineral Wells, Texas

NEW...FROM
This equipment will help you

HOBBS HYD-PAK

Manufactured under U. S. and Canadian Patents
Other Patents Pending

60 model

only 19" above chassis frame!

install on any chassis

60 model has lower loading height, watertight body, 3 "extra" yards

1960 HOBBS HYD-PAK's loading hopper opening is 4" closer to the ground, just 19" above chassis frame – less "lift" for the pick-up men! Hopper's watertight, too, because hydraulic cylinder which drives packer blade now is above floor line, eliminating need for slot in hopper at floor level.

HOBBS HYD-PAK bodies continue to give 3 cu. yds. more compressible capacity than other packers of comparable weight and cost (see specs below); means less rolling stock, fewer trips to dump. They're also • SAFE – loaded at curb side, not from street; safety switches both sides • SIMPLE – all types refuse is loaded, *without selection*, manually or via containers • SANITARY – no odors or liquids escape • SPEEDY – high compression cycle completes in 30 seconds or less; simple rear dump also saves time • STRONG BUT LIGHT – steel construction is fully reinforced, but lightweight; no need for big expensive trucks.

HOBBS HYD-PAK MODEL 60 SPECIFICATIONS

BODY MODEL		6013	6016	6020	6024
Total Capacity	Cu. Yds.	16	19	23	27
Compressible Capacity	Cu. Yds.	13	16	20	24
Length	Inches	170	170	194	230
Width	Inches	95	95	95	95
Top of Frame to Top of Body	Inches	71	81	81	81
Weight, Body	Lbs.	6000	6900	7300	8300
Average Load	Lbs.	7700	9500	11,800	15,500
Body and Load	Lbs.	13,700	16,400	19,100	23,800
Recommended Chassis	Inches, Min.	102	102	120	154
Cab-to-Axle	Max.	126	126	138	170

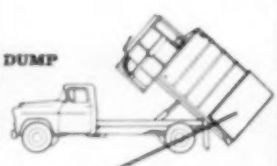
HERE'S HOW HOBBS HYD-PAK WORKS:

Refuse is loaded, *without selection*, into extra large hopper openings; hinged doors in hopper roof can be opened if necessary.

Compression cycle is started by convenient lever extending to both sides of unit; safety switches are right below.

Vertical sliding doors move up automatically (on deluxe model) to cover openings.

Hydraulic action moves compressor blade back thru hopper, packing refuse into main storage area. Retaining angles hold load as blade returns for reload.



Rear doors are opened and load is dumped hydraulically, quickly and smoothly. Body is slightly wider at rear so even tight loads come out easily.

HOBBS HYD-PAK DIVISION, HOBBS TRAILERS, FORT WORTH

HOBBS HYD-PAK
save money on refuse collection

(PATENTS PENDING)

Container system handles commercial and residential pick-ups on same haul

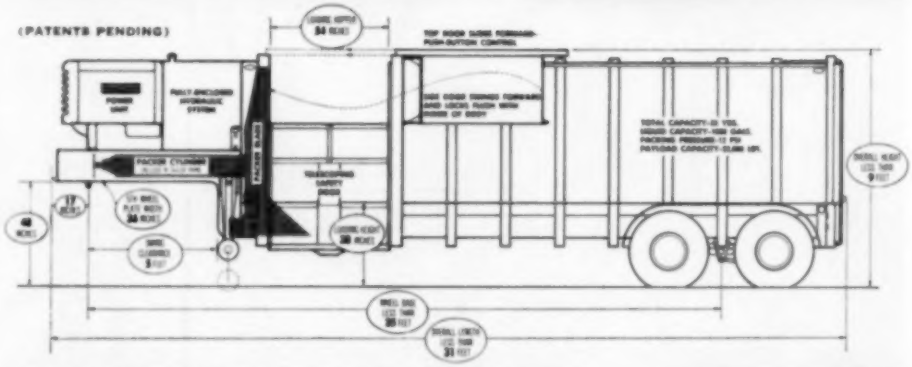
HOBBS HYD-PAK brings you the simplest, lowest-in-cost container system yet. Simple and safe because it's built around positive-action rack-and-pinion gear — no cables or long attachment arms (and only one grease point!) Dump and compression cycles are co-ordinated automatically because power from both comes from same hydraulic source. Low-cost because it handles both 1½- and 2-cu. yd. steel containers *and* manual loads on hauls where pick-up methods vary — from street, dock or intermediate levels. At left, note stability at top of container-dump cycle.

THIS IS ALL THERE IS TO IT:
Lift bar at right installs on any HOBBS HYD-PAK, makes it a container-loader. Bar folds down out of way when manual loading is desired.

Trailer-Pak has volume, versatility

Trailer-Pak is the economical, time-saving answer to long, high-density routes, far-away dump sites, large operations with few trucks and personnel. Big enough to work as transfer unit for smaller trucks, yet short enough (31') for alley work. Offers all rugged construction features of HOBBS HYD-PAK bodies, plus heavy-duty springs to absorb road-shock. Packer blade compresses refuse into storage area in normal loading cycle. To unload, blade moves entire length of trailer.

(PATENTS PENDING)



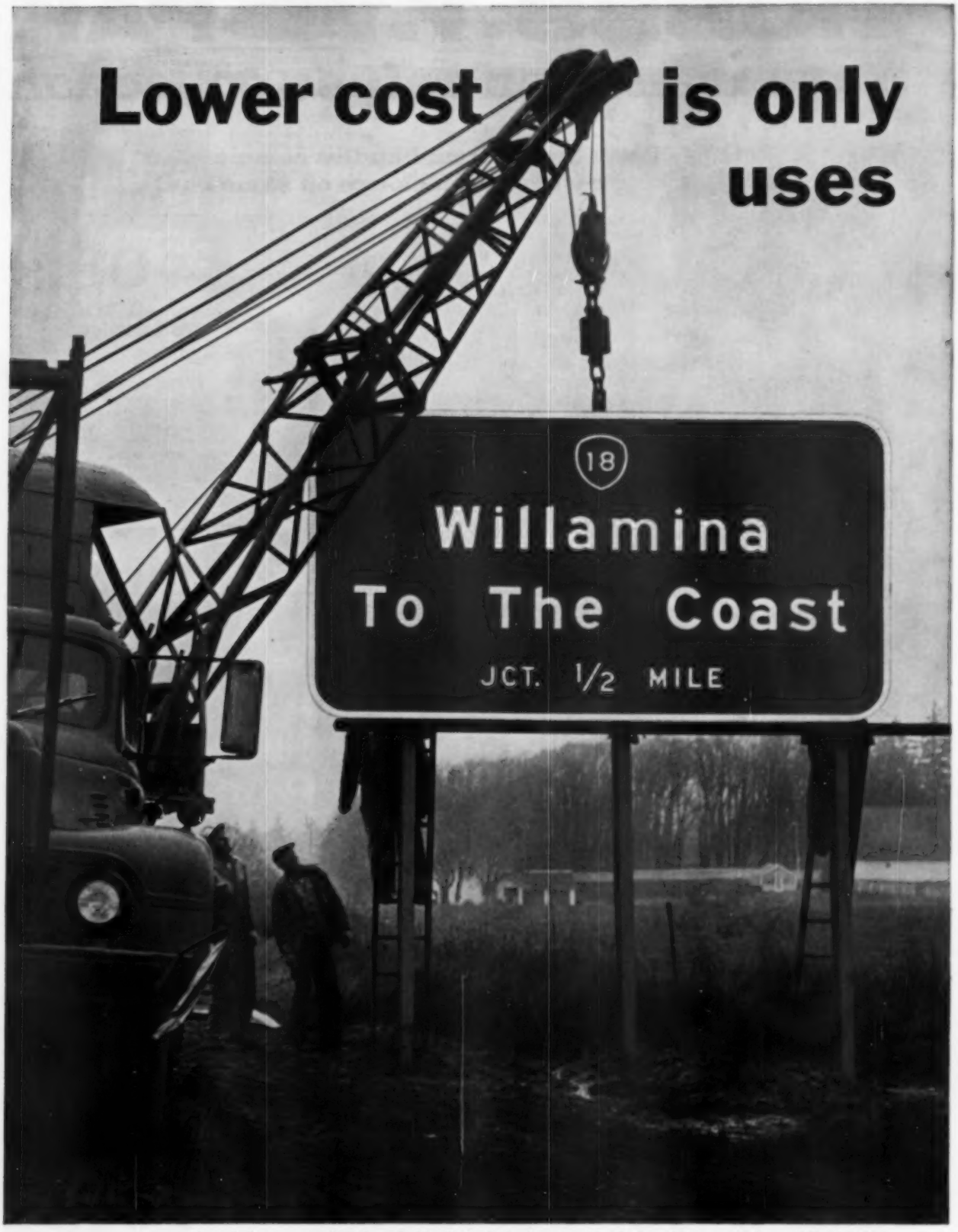
HOBBS HYD-PAK DIVISION, HOBBS TRAILERS

609 NORTH MAIN **FORT WORTH, TEXAS** **ED 6-0404**

DISTRIBUTORS THROUGHOUT WESTERN HEMISPHERE — CABLE HOBBSCO

CALL, WIRE OR WRITE TODAY FOR DEMONSTRATION

HOBBS HYD-PAK



New colorfast green overlaid plywood with reflective button legend and border is used for green background direction signs.

one reason why Oregon signs of overlaid plywood

MODERN REFLECTORIZED OVERLAID PLYWOOD signs do a better job for the taxpayer as well as the motorist in Oregon.

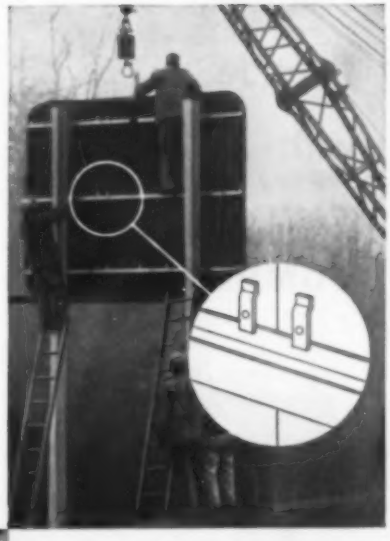
State highway officials estimate the overall cost of an overlaid plywood sign installation averages 20 percent less than other acceptable materials. Savings are based on lower basic material costs, faster fabrication and finishing (neither sign face nor back is painted; reflective legend is applied direct)—plus elimination of the need for special back framing on signs up to 40 square feet in area.

But lower cost is only part of the story. Basically, Oregon uses overlaid plywood because it makes a strong, good-looking sign that stands up under prolonged weathering and deliberate or accidental abuse.

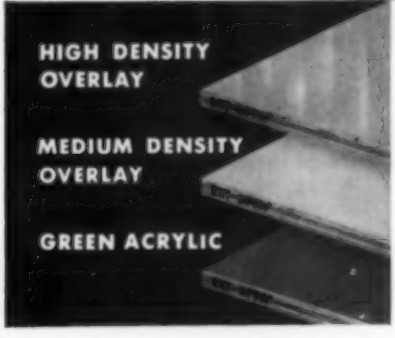
All told, the state maintains over 100,000 signs; 47,000 informational, 20,000 warning and 35,000 regulatory. Ninety percent are reflectorized, with reflective legend and border applied directly to the overlaid plywood surface. Key directional signs are illuminated. Black high density panels are used for warning and regulatory signs. New color-fast green acrylic overlaid plywood is used for green background direction signs to conform to national color coding on Interstate and other highways.

FOR MORE INFORMATION (detailed specifications, application data, etc.) write:
DOUGLAS FIR PLYWOOD ASSOCIATION
TACOMA 2, WASHINGTON
—an industry-wide organization devoted to research, promotion and quality control
Always specify by DFPA grade-trademarks

DFPA TESTED QUALITY



New panelized sign system used on recent Oregon installations employs standard aluminum girts and special clips. System is highly economical, permits flexibility in sign sizes and shapes. Developed by Douglas Fir Plywood Association, it meets all AASHO standards.



Medium density overlaid plywood is for plain painted signs; **high density** requires no paint protection and permits direct application of reflective sheeting. **New acrylic overlay** comes in green and white for signs with painted or reflectorized legend.

1-
2-
3 steps
and
you
make
accurate
tests
for
pH,
chlorine,
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with
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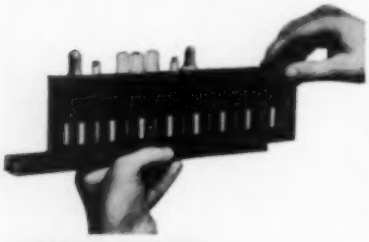

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WRITE FOR FREE HANDBOOK
101 pages of technical data and useful information. Gives theory and application of pH control. Describes Taylor line.

W. A. TAYLOR AND CO.
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CHEMISTRY FOR SANITARY ENGINEERS

This is an excellent book and one that is much needed. Many sanitary engineers lack the chemical knowledge desirable today. Here they will find a text that starts at an understandably elementary level and proceeds from there on to cover the subject admirably. The material is presented in two parts. The first nine chapters provide information on basic chemistry and on the eight fields of general, qualitative, quantitative, organic, physical, colloidal, biochemistry and radiochemistry. The second part covers water, sewage and industrial waste analysis and the chemistry and other data involved in the usual determination and analyses performed by or available to sanitary engineers. By Clair N. Sawyer, Director of Research for Metcalf & Eddy. 353 pages; illustrated; McGraw-Hill Book Co., Inc., 330 West 42nd St., New York; $9.50.

MOSQUITOES OF MEDICAL IMPORTANCE

This is a newly published 158-page handbook available from the Entomology Research Division, Agricultural Research Service, Department of Agriculture, Washington 25, D. C. Our information is that it appears to be available without charge.

SOLVING DRAINAGE PROBLEMS

This is the third edition of a very useful booklet on corrugated steel pipe for drainage. It includes new tables for evaluating flow friction but it also has a lot of other very useful information. Such basic data are given as estimating runoff, selecting rainfall rates, subsurface drainage procedures, jacking the pipe, farm pond spillways and pipe beam strength for stream or ditch crossings. Booklet 425-B; 80 pages; tables; well illustrated. Bethlehem Steel Co., Bethlehem, Pa.

MANUAL OF SEPTIC TANK PRACTICES

An addendum to Public Health Service Publication No. 526, Manual of Septic Tank Practice, has been issued covering an improved method of underground distribution system arrangement. (See Public Works for February, 1959). Copies of the addendum from Public Inquiries Branch, Public Health Service, HEW, Washington 25, D. C.

APWA 1959 YEARBOOK

This yearbook contains the directory of members of the American Public Works Association and also lists of officers and committees. Also included are the papers and panel reports presented at the Seattle meeting in September, 1959. Among these are the Forums on Solid Wastes, on Streets and Highways, on Water and Sewage and on Buildings and Equipment. Also included is the report on the Workshop of Administration Problems. There are 434 pages; paper bound; $5. American Public Works Assn., 1313 East 60th St., Chicago 37, Ill.

METAL PIPE CULVERT DATA

Two papers on metal pipe culverts are included in this 24-page booklet of the Highway Research Board. One is a study of the corrosion of corrugated metal culverts in California by J. L. Beaton and R. F. Stratfull covering examination of 7,000 culverts. The other is a report on a laboratory investigation on the influence of soil characteristics on deformation of embedded flexible pipe culverts by Reynold K. Watkins, Highway Research Board, 2101 Constitution Ave., Washington, D. C.; 50 cents.

MANUAL OF INSTRUCTION FOR WATER PLANT OPERATORS

The text used in the two-weeks Grade II Water Treatment Plant Operators' Course in New York is now available for distribution outside the state. Produced by the Bureau of Environmental Sanitation and Office of Professional Training of the New York State Department of Health, the book places emphasis on fundamental principles rather than the details of operation technique. Among the subjects presented are basic hydrology and hydraulics; chemistry; bacteriology; and methods of water treatment. The presentation is restricted in scope, covering only those phases an operator is most likely to be con-

with the cost-cutting help of this new JOHN DEERE LOADER-BACKHOE

Here's the outfit that's making a lot of cost figures obsolete—giving many municipalities a welcome break on construction expenses.

The reasons are low first cost and outstanding fuel economy, plus consistently high work output.

Self-leveling, the new 831 Loader gets the 7/8-yard heaped load into the truck fast—and with a minimum of effort. When bucket is dumped from full height, it returns to digging angle by use of the *boom-control only*. A 35-degree bucket roll-back provides the heavy pry-out needed for full loads.

The 51 Backhoe combines 2-lever digging with plenty of power and unusual flexibility. In minutes, one man out on the job can set the boom-mounting to any of five positions from flush left to flush right, using only a wrench.

For details, and a demonstration, see your John Deere Industrial Dealer.

JOHN DEERE
INDUSTRIAL DIVISION
3300 RIVER DRIVE
MOLINE, ILLINOIS

JOHN DEERE *"Specialists in Low-Cost Power with a Heavyweight Punch"*

CUT 20" CAST IRON PIPE
in Less Than 8 Minutes...

...with the New REED
ROTARY CUTTERS
(4 sizes cover the range from 10" cast iron to 26" steel pipe)

These one-man Reed Rotary Cutters cut large diameter steel or cast iron pipe *faster and better than the heaviest power machines* . . . and without electrical or explosive hazards. What's more, there's less digging in ditch-work! You need only a 4" to 6" channel under the pipe and a 45° to 60° arc for the handle swing. Reed Rotaries are easy to "carry in", too. The 20" size weighs only 68 pounds; separates into 3 easily carried parts. Patented pipe guide assures clean, right-angle cuts. Four razor blade wheels track perfectly, cut easily and are quickly interchangeable for steel or cast iron pipe.

● Write today for descriptive literature.

These typical cuts on 12, 16, 20 and 24" cast iron pipe illustrate the clean, accurate, right-angle cuts provided by Reed Rotary Cutters.

REED MANUFACTURING COMPANY
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cerned with and it is written to be understood by those with little technical background. A feature of the book is a glossary defining more than 400 terms commonly used in the profession. The 164-page book is paper bound and is obtainable by those residing outside of New York State from the Health Education Service, Box 7283, Albany 1, N. Y. The price is $1.00 for single copies or 75 cents per copy on orders for 25 or more. Postage and shipping charges in the U. S. A. are prepaid. Those residing in New York State may obtain copies from the New York State Department of Health at Albany.

INTERGOVERNMENTAL RELATIONS IN STATE HIGHWAY LEGISLATION

This 100-page text reports a study to ascertain how the several states have divided the legal authority and responsibility for roads in the various highway systems between state and local governments, as well as the extent of cooperating authority granted the various governmental units. This is a report on statutory law only and does not include judicial decisions; neither does it include administrative practices or working relationships. Highway Research Board, 2101 Constitution Ave., Washington, D. C.; $3.20.

NEWPORT NEWS ANNUAL REPORT

The annual report for the City of Newport News, Va., has been issued as a supplement to the *Daily Press* for Jan. 31. This is an excellent simply told story of the activities and progress in this growing city. J. C. Biggers is City Manager and Sol Ellenson is Commissioner of Public Works.

HIGHWAYS AND ECONOMIC DEVELOPMENT

This bulletin contains studies on land use and values and the effects of highways and expressways on local properties. There are six papers covering a wide range of conditions and places. 88 pages; $1.60; Highway Research Board, 2101 Constitution Ave., Washington, D. C.

• • •

Pan American Highway Congress

The eighth Pan American Highway Congress will be held in Bogota, Colombia, May 20 to 29. A program and other data concerning the meeting can be obtained from Francisco J. Hernandez, Permanent Secretary of the Congress, Pan American Union, Washington 6, D. C.

4 who bought Ford Tractors . . . and *WHY*

"Price"

says Jackson

president of "Pools of Distinction,"
Jacksonville Beach, Florida.

"We style and custom build swimming pools of all sizes, 15′ x 30′ and up," says Mr. Jackson. "Our Ford tractor digs and shapes the cavity with a backhoe. Then we use the loader to stack earth around the walls and raise the pool level.

"We figure Ford saves us over $100 a pool," he adds. "We're very pleased with our dollar savings in operation and maintenance costs. But these were benefits we learned about by experience. What attracted me to Ford in the first place was price. Comparing features and work capacity with others on the market, I couldn't find anything else to match Ford."

PRICE? THESE ARE THE FACTS WITH FORD*

Ford Workmaster Tractors—$330 Under Average

(Comparison power range—34 to 47 engine HP)

Ford Model 621 tractor's retail list price is $63 less than its nearest competitor among 10 other utility tractors, and $330 less than the average price for all 10—seven of them having less than Ford's 45 engine HP. Ford's price of $48 per engine HP is $5 less than its nearest competitor, and $13 less than the average for all 10.

Ford Powermaster Tractors—$1,138 Under Average

(Comparison power range—51 to 72.5 engine HP)

Ford Model 821 tractor's retail list price is $667 less than its nearest competitor among five other utility tractors, and $1,138 less than the average price for all five. Ford's price of $39 for each of its 62.5 engine HP is $12 less than the No. 2 tractor, and $19 per HP less than the average for all five.

Ford Diesel Tractors—$409 Under Average

Diesel engines are a factory-installed option for all series of Ford tractors. In each power class, Ford costs less than all comparably equipped competitors. Each Ford diesel option costs only $420 more than the same Ford tractor in a gasoline model. Among the nine other more popular diesel tractors, the average mark-up for diesel as compared to gasoline models is $829. Ford's mark-up is $409 less than the average for these other diesels, and $130 less than its nearest competitor.

Ford Industrial Tractors—$474 Under Average

(Comparison power range—51 to 72.5 engine HP)

Ford Model 1821 tractor's retail list price is almost the same as one other industrial tractor in its power class ($3 less, to be exact), but it is $474 less than the average price of the five others in this class. Ford's price of $49 per engine HP is a dollar less than the No. 2 tractor and $8 less than the average for all five. Perhaps even more important, when all of these units are equipped with loaders, Ford is first in breakaway, a close second in rated lift capacity and the leader by a big margin in overall productivity. Ford moved 13 tons of material an hour more than its nearest tested competitor!

*All comparisons are based on tractors equipped comparably to the Ford models cited. Retail list prices are F. O. B. factory and will result, of course, in variations of delivery price according to point of purchase. Comparisons are based on the most recent published data held by Ford at the time of printing, and are believed to be an accurate reflection of suggested retail list prices before addition of shipping charges, state taxes, etc.

4 who bought Ford Tractors . . . and *WHY*

"Dependability"

says *John A Behnken*

president of Behnken Coal and Materials Company of New Athens, Illinois.

"One operator with Ford loads out 200 tons of limestone in 8 hours," Mr. Behnken says. "That's a $600 payload and twice the amount four men used to load in four days. Ford loading efficiency saves coal customers $1.40 a ton. And we gain at least 50c a ton price advantage on quarry materials because fast loading lets us stockpile.

"But probably the biggest thing to me—the reason I'll always buy Fords—is dependability. I've got one tractor 14 years old and another one 10 years old. They've averaged 25,000 tons of rock, sand and limestone, and 6,000 yards of dirt a year ever since.

"Both have been in constant service and with just about everybody among our 30 people operating them at one time or another," he continues. "Yet we've never had a major repair and never had a parts replacement involving either engine!"

DEPENDABILITY? THESE ARE THE FACTS WITH FORD

Over Two Million Ford Tractors

In manufacturing as in most other fields, there's no substitute for experience to produce machines giving the years of dependable performance described by Mr. Behnken and thousands of other Ford tractor owners. Ford has more tractor experience than any other company, today is well on the way toward its three-millionth tractor.

World's First Mass-Produced Tractor

In 1917 the world saw its first Fordson. During the next decade it saw more than 700,000 of them—some three-fourths of all U.S. tractor production. In 1939 Ford introduced built-in hydraulic systems with its model 9N Ford tractor. Sixteen years later Ford produced its one-millionth tractor with revolutionary three-point hitch and hydraulic system.

Birth of the "Red Tigers"

In 1952 Ford produced the first of the "Red Tiger" engines which still today are such a vital part of Ford tractor dependability, Since that time—more than three-quarter million engines ago – they've been refined, given more power, improved in many ways. But each has added to the Ford fund of experience which goes into the production of today's—and tomorrow's—Ford tractors.

Only Tractor Maker with Auto Experience

Ford is the only member of the tractor field with ready access to the production experience, the depth of research and the foresighted engineering of the auto industry. Ford's new and exclusive Select-O-Speed transmission, for instance, drew heavily on the experience gained with planetary gearsets in many millions of Ford autos. Ford Tractor and Implement people are quick to adapt all proven processes and economies to their own production . . . benefits which loom big among the many reasons for Ford's consistently high quality, Ford's traditional low cost.

4 who bought Ford Tractors . . . and *WHY*

"Versatility"

says *Carroll Blackden*

president of Krete Kraft Concrete Products Company of North Hampton, New Hampshire.

"Our Ford tractor and loader paid for itself in less than a year," says Mr. Blackden, whose company is the largest producer of concrete septic tanks in New England. "It enabled us to handle easily a 20% increase in production.

"Considering the constant heavy use this Ford tractor gets, it is a real tribute to its rugged design that our maintenance costs have been so very small. But I believe the biggest Ford feature is versatility. Our tractor works about half-time loading aggregate and pouring cement, about half-time storing and truck-loading distribution boxes, tank covers, etc.

"In addition," Mr. Blackden says, "the unit is used for occasional work in home construction, and for snow removal at the plant about 10 days a year. It's the steadiest worker on the job and the most versatile piece of equipment we have."

VERSATILITY? THESE ARE THE FACTS WITH FORD

Wide Range of Tractors

Ford offers a line of tractors with power and equipment for almost any materials handling or grounds maintenance job. Six different Workmasters, five Powermasters and five Ford Industrial tractors—all with diesel engine options which in effect double the selection to 32 models. They range from Special Utility models—for drawbar operations and work not needing hydraulic systems—up through fully equipped tractors with the new Select-O-Speed transmission and two-speed power take-off. Ford also offers Utility and All Purpose models of the big Fordson Power Major Diesel, the new Fordson Dexta Diesel, and both Standard and High Clearance models of the new Ford Offset tractor for nurserymen and landscapers. With Ford you choose your weight, your power, your tractor equipment and your work capacity . . . select exactly the right tractor for *your* job.

Wide Range of Basic Attachments

You'll find exactly the right Ford attachment for your job, too. Loaders with 1,000 to 2,500-lb. rated capacity; 10 ft., 12 ft. and 14 ft. backhoes; 6′ or 7′ front and rear blades; 65″ to 80″ rollover and box type scrapers; tiller rakes; 60″ and 100″ rotary cutters; 6′ and 7′ cutter bar mowers; 6′ and 8′ lime and fertilizer spreaders; cordwood saws, posthole diggers and many other attachments designed to save time, men and money on dozens of jobs.

And an Ever-Growing List of Specialized Equipment

Your Ford Tractor and Equipment dealer also sells many other attachments for Ford tractors. Brooms, winches, fork lifts, air compressors, side booms, sprayers, aerating tools, rollers, trenchers, pumps, reel mowers, compactors, portable welders . . . the list seems almost endless, and in almost every case fulfills a real need in replacing costly hand labor. Just give Ford a try. You'll soon find it's the busiest worker on your job.

4 who bought Ford Tractors . . . and *WHY*

"Service"

says *Carmen Oliver*

partner, Oliver Bros. Landscaping of Tonawanda, New York.

"We take over landscaping jobs two or three inches from finished grade," Mr. Oliver says, "and spread top soil, rough grade, backfill foundations, finish grade, seed and fertilize. Three Fords with loaders, blades and other attachments are operated 10 to 12 hours a day, six days a week.

"Ford has cut our operating costs at least 50%," he adds, "and in 24 years of operation—the combined total of the four Fords we've owned—we've never yet had any significant down time.

"We practice our own preventative maintenance and dealer service is seldom needed. When we *do* need our dealer, though, he always comes through for us. The service is excellent and you can understand how important that is to us when you watch how much Fords are a part of our day-to-day operation. We just couldn't afford any major down time."

SERVICE? THESE ARE THE FACTS WITH FORD

Wherever You Are, Ford's Not Far

In every state, in almost every county in the United States, there's a dealer, distributor or manufacturing plant for the Tractor and Implement Division of Ford Motor Company. You're only a few hours, at most, from dealer parts stocks . . . only a phone call away from the even bigger stocks held in reserve by Ford's 29 Distributors and Sales Districts.

Ford Reputation on the Line

When you buy Ford tractors and equipment, you also receive the "job security" of an authorized Ford Tractor dealer's parts and service warranty. You're also buying the future bonus of Ford's excellent trade-in values.

See Your Dealer Soon

These are just a few of the many reasons why Fords are replaced with Fords, and why more companies add Ford to their equipment every week. Owner satisfaction stems not just from the product, but to a large extent from the man who sells it and keeps it working. Have you talked to your Ford Tractor and Equipment dealer lately? He's selling the most basic job needs—economy, dependability, versatility and service. He's selling satisfaction. Get yours right away!

TRACTOR AND IMPLEMENT DIVISION • FORD MOTOR COMPANY • BIRMINGHAM, MICHIGAN

Ford

INDUSTRIAL TRACTORS AND EQUIPMENT

quickly installed in old piping!

MUELLER® copper meter yokes

NEW compression couplings

...for steel or copper pipe
...with or without locking nut

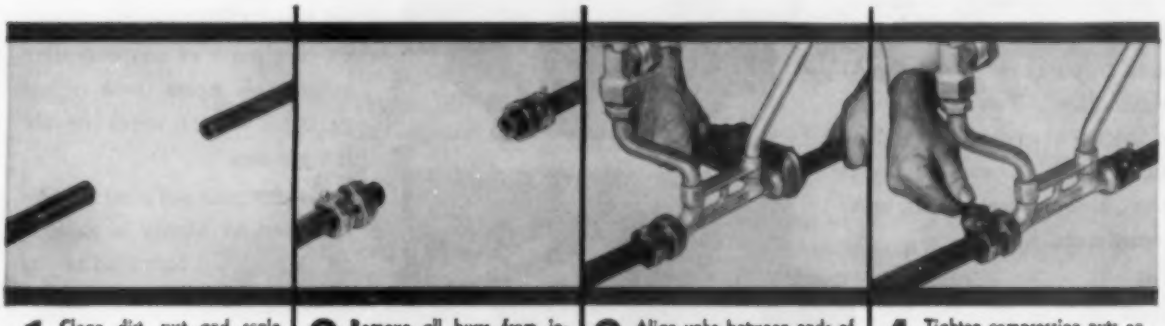
You can now install Mueller Copper Meter Yokes in any existing steel or copper piping in just a few minutes — and without cutting threads or sweating joints.

The simple step-by-step procedure for installing a yoke with Mueller's new Compression Couplings is shown below. Permanent, water-tight joints are quickly made even on rough and badly pitted pipe. Possible trouble is avoided because the piping does not have to be moved.

These new, time-saving couplings are now available for all Mueller Copper Meter Yokes with Multi-Purpose Ends. Regular compression nut or locking nut designs can be furnished for steel or copper pipe.

The locking nut type (shown) positively prevents any movement of the yoke on the pipe and insures continuous electrical bonding of the service piping.

Write for complete information and specifications on Mueller's Copper Meter Yokes.



1 Clean dirt, rust and scale from pipe and cut out a section just slightly longer than yoke (without coupling).

2 Remove all burrs from inside and outside of pipe and slip complete coupling over cleaned ends of pipe.

3 Align yoke between ends of pipe, slide couplings into place and tighten couplings securely onto yoke body.

4 Tighten compression nuts on pipe and lock yoke in place by tightening locking set screw on clamp. Setting complete.

Copper Meter Yokes are just a portion of Mueller's complete line of quality-matched meter setting equipment.

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles;
In Canada: Mueller, Limited, Sarnia, Ontario.

What Every WATER SUPERINTENDENT Should Know About

AMERICAN METERS

Full Interchangeability of Parts

You can order a part for an American Meter that is 20 . . . 30 . . . yes, 40 years old and it will fall into place — a perfect fit.

Full interchangeability of **parts** in American Meters eliminates the need to purchase costly "unit-assemblies". You replace the individual worn parts and nothing more. This means lower parts costs, lower inventory costs, lower repair costs.

Such interchangeability is achieved by precision manufacture and the finest quality control. It is possible, too, because American Meters are simple and uncomplicated. They have the fewest moving parts of any complete meter. This means more rugged parts for longer, more trouble free service.

Read about this and other features of American Meters in Bulletin 58. A copy will be mailed to you on request.

BUFFALO METER COMPANY
INCORPORATED
2920 Main Street Buffalo, New York

That's Lock Joint Concrete Pipe!

Whether it be the largest concrete pressure pipe in the world, or a small diameter drainage pipe;
. . . . pipe for the highest heads common to water works practice, or pipe for only nominal pressure or partial vacuum;
. . . . pipe to resist extremes of overburden, or pipe to meet the complexities of industrial or plant piping;
. . . . LOCK JOINT can provide all these, and more.

You will also find it a dependable, durable, maintenance-free pipe of sustained high carrying capacity which is backed by a company with over a half century's experience in the development and production of concrete pressure, sewer, culvert and subaqueous pipe.

LOCK JOINT PIPE CO.

East Orange, New Jersey

Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Kan. • Perryman, Md. • St. Paul, Minn. • Winter Park, Fla.

Pressure • Water • Sewer • **REINFORCED CONCRETE PIPE** • Culvert • Subaqueous

Spring...

now is the time to properly light your construction hazards

USE THE

DIETZ 3 WAY HAZARD WARNING SYSTEM

LANTERNS TORCHES VISI-FLASH

Use Dietz Visi-Flash Lights to alert the oncoming driver. Brightest, safest, most trouble-free flashers on the market. Warn "Danger Ahead" for up to 1500 hours without changing batteries.

Use Dietz Lanterns to locate hazard in relation to driver's position. Show exact location, shape, extent, and boundaries of hazard area. Burn up to 100 hours.

Use Dietz Torches to guide driver around the hazard. Fully illuminate the danger in every weather. Burn up to 48 hours on low cost kerosene

Go **DIETZ** *and you go Safely*

It's Spring . . . more highway projects . . . more traffic, too!

On your jobs . . . play it safe. Proper lighting of your highway hazards can save you many a headache — as well as money and your reputation.

NEW! **DIETZ HAZARD WARNING PLANNER**

A Practical On-the-Job Tool! Quickly and easily shows how, when, and where to use each type of warning light for maximum safety under all weather conditions and all types of roads and speeds.

Send $1.

for each Planner — personalized with your name

R. E. DIETZ COMPANY

111 Leavenworth Ave. Syracuse, N. Y.

John C. Lilly is City Manager of Stockton, Calif., a position he has held since 1953. As such, he is responsible for the entire planning, direction and control of the City administration, including Public Works, largest of all the City departments.

Stockton, with an area of more than 22 square miles, has 91,000 residents and a metropolitan population of 150,000. As the center of the rich San Joaquin farm area it has experienced great expansion in population and industrial development. The factors of area, population growth and food processing have had a tremendous impact on the Public Works activities of the City. To accommodate canning and industrial waste, the City has had to provide sewers and treatment facilities equal to those of a city of 840,000 people. The large land area has required the installation of a storm and sewage system far above normal for a city of Stockton's size. A $1.5 million industrial sewage trunk line has been constructed.

Under Mr. Lilly's direction, over $10 million of capital improvements have been constructed or are being built. These include vehicular bridges of the latest type and design; an off-street parking program with 3 multi-level garages to relieve downtown parking; the first underpass built by the City in 32 years; and two grade separations. A continual program of street widening and traffic alleviation has resulted in a 41% reduction in severe injury accidents on Stockton streets during the years 1956-1958.

Mr. Lilly held a series of city government posts following his graduation with a Master's Degree from College of the Pacific. During World War II he served as an officer in the Army Air Force. He is a member of the International City Managers' Association. During his limited spare time he enjoys working in the garden with his wife, who was recently honored as "Stockton's Woman Citizen of the Year." Mr. and Mrs. Lilly have one daughter, Margot, a student at California, and a son, John.

Lloyd G. Byrd Joins Editorial Staff of PUBLIC WORKS

Lloyd G. (Gary) Byrd, who has been Maintenance Engineer of the Ohio Turnpike since the first year the facility was opened, joined the Editorial Staff of PUBLIC WORKS on Feb. 29. Prior to his service with the Ohio Turnpike Commission he was an Assistant Engineer with the Ohio Department of Highways. He is a graduate of The Ohio State University (1950) with a BS degree in Civil Engineering and is a registered professional Engineer in Ohio. An Army veteran, he was introduced to engineering through the medium of the Army Specialized Training Program to which he was assigned during 1943-44, with work at the University of Michigan. He is no stranger to good writing. He won first place for two consecutive years in Ohio and second place nationally in the AASHO student essay contest. He was the author of the lead article in January PUBLIC WORKS.

His duties on the Ohio Turnpike included responsibility for approximately 200 employees and an annual budget of $1,500,000. In addition to developing and administering the maintenance program on the 241-mile Ohio Turnpike, he was responsible for eight sewage treatment plants, six water treatment plants and 42 office and service buildings. His broad experience in highway and other public works engineering and administration fits him exceedingly well for his new work. In addition, he has been active in many phases of civic, church and Boy Scout activities.

INSTANT BRUSH DISPOSAL

FITCHBURG CHIPPER

DOES 3 MEN'S WORK

When you want to cut brush disposal cost, investigate a Fitchburg Chipper, a real time and labor-saver.

John Glasgow, Superintendent of Public Works, Township of Mahwah, New Jersey, says: "Now I chip brush instead of putting it on piles and waiting for wet weather to burn. I mention wet weather because of fire hazard.

"The Fitchburg Chipper was purchased in May 1954. It will take only a short time to pay for itself. I hired 6 men to cut and clean up brush, now with the Chipper I only need 3 to do the same work."

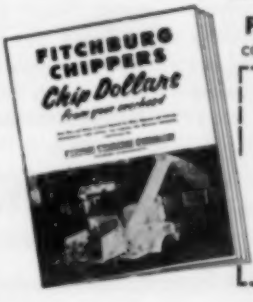
You, too, can save man hours where there is a need for line clearance operations, road clearance, thinning out woodlots, or handling the brush problem on parkways, city streets, etc.

The Fitchburg Chipper is designed for rugged use, and in models priced from $960 upward.

Learn about Fitchburg's exclusive spring-activated feed plate, which makes chipping of all sizes of wood (up to the machine's rated capacity) simple. Another exclusive feature is the hinged feed apron which can be closed when not in operation.

Read how others cut labor costs with a Fitchburg Chipper—the only chipper that gives you a one-year guarantee.

Send For New Free Booklet-"**CHIP DOLLARS FROM YOUR OVERHEAD.**" Complete with cutaway color drawings of Chipper in action. Specifications, etc.



FITCHBURG ENGINEERING CORPORATION

Department PW-43, Fitchburg, Massachusetts

Send my free copy of "Chip Dollars From Your Overhead" to:

Name_____ Position_____

Address_____

Town or City_____ State_____

COLOR ADDS A NEW DIMENSION FOR SAFER HIGHWAY MARKING

...Parlon keeps it bright

Colored traffic paint has been in use for several years as a special signal—for instance on the green crosswalks used in so many communities to protect school children and pedestrians. Here is an extension of that application, being used with notable success by an Eastern state on its most heavily travelled highways.

The use of color—a brilliant green approximating the grassy areas of island and median strip—provides a distinctive run-out area on the pavement before the vehicle comes in contact with curb or barrier. This is particularly effective where traffic-stream divergences, cross paths, and other unexpected pattern irregularities exist to confuse the high-speed motorist. The color areas advise the motorist of the impending change, guide him to the correct lane markings, and give, where necessary, a safe haven for stopping before the curb is mounted.

In these new uses for color on street and highway surfaces, as in all conventional striping, laning, edge-marking, and stenciling applications, traffic paints made from Parlon® chlorinated rubber can be depended on for long life and for the fast dry that opens the roads to traffic sooner. Ask your regular paint supplier for the test data on Parlon that proves these values. Or, if you prefer, write for a showing of the motion picture "Highway Life Lines" which tells how the right paint can be safely and easily selected and specified.

Cellulose Products Department
HERCULES POWDER COMPANY
INCORPORATED
Wilmington 99, Delaware

CPD-1

. . . is cut to a minimum when you treat gravel roads with Sterling Rock Salt!

Every spring brings new evidence that salt-treated roads are relatively unaffected by potholing, frost heaving and aggregate loss. In most cases, only infrequent blading is needed to keep these roads in good shape from year to year! This greatly reduced maintenance, coupled with the original low cost of Sterling Rock Salt treatment, permits highway departments to devote a larger share of their budgets to other important road-construction work.

Special equipment is no longer needed for effective salt treatment of gravel roads. Last year, International Salt Company introduced a simple, practical 7-step method which is fully described in a free booklet, "Better Roads." Send today for your free copy, and learn how Sterling Rock Salt treatment can work in your area.

Service and research are the extras in

STERLING ROCK SALT

INTERNATIONAL SALT COMPANY

International Salt Company
Department PW-360
Clarks Summit, Pennsylvania

☐ Please send free booklet, *Better Roads.*

☐ Have a Sterling representative call.

*Name*_____

*Address*_____

*City*_____ *State*_____

Your sewer investment will never choke up when you use AMVIT Jointed Clay Pipe

Substitute non-clay pipe swells from acid and chemical action on cement

The photograph on the right shows a piece of asbestos-cement pipe which failed after only a few years service.

It is made of asbestos fibre, silica sand and portland cement. Acids formed by domestic sewage, ground up waste and detergent water, destroyed the cement and caused the pipe to swell, which blocked the vital sewer line. Tightness of the joint did not save the pipe from destruction.

Substitute non-clay pipe such as this cannot stand the wear of ordinary service. Replacement costs taxpayers thousands of dollars.

Like the clay pipe, the plastic Amvit joint is acid resistant and will not corrode or decompose like most non-clay pipes.

The alignment of the Amvit joint assures that the pipe is self-centered at all times. This results in better flow characteristics and self-cleansing action.

This is an actual photograph of a substitute pipe failure.

Because of this super-smooth interior surface a lower Kutters "n" value can be used in design.

For more information on how Amvit can help cut sewer project costs, write or call American Vitrified Products Company, National City Bank Building, Cleveland, Ohio, or our office nearest you.

REGIONAL OFFICES:

Cleveland	TO 1-6750	Los Angeles	EL 9-4535
Chicago	ST 2-5243	Milwaukee	HO 6-4990
Detroit	GA 1-1940	St. Louis	HA 9-5400

Somerville, N. J. FO 9-4378

SINCE 1948

AMERICAN

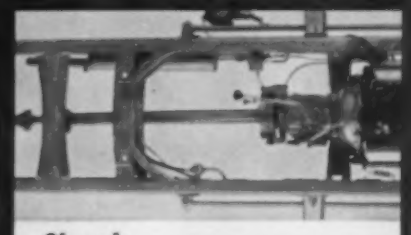
American Vitrified Products Company

CLEVELAND OHIO

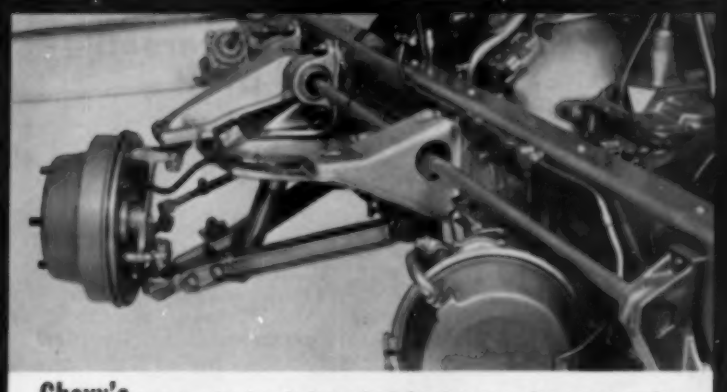
Plants Across the Nation... Brazil, Indiana • Chicago, Illinois • Cleveland, Ohio • Crawfordsville, Indiana • Detroit, Michigan • East Liverpool, Ohio • Grand Ledge, Michigan Lisbon, Ohio • Los Angeles, California • Milwaukee, Wisconsin • South Bend, Indiana • St. Louis, Missouri • Whitehall, Illinois • Somerville, New Jersey (Completion early 1960).

Chevy's major components for 1960 last up to four times longer than ordinary truck parts—exhaustive testing has proved it. Likewise, the totally new cabs have proved 67% more resistant to twisting; and new frames for many models are as much as 4.8 times stronger in torsional rigidity. These are typical 1960 Chevrolet truck facts and figures—and they point up a new kind of tough truck build that helps you hang on to your dollars!

Chevy's precision-balanced wheels run smoother. Balancing weight shows that all front wheels are balanced in assembly—an advantage no other truck offers. It's assurance of easy handling; that tires will last longer without shimmy and shake from wheel imbalance.



Chevy's new frames are built with new brawn. Box-section rail design is stronger than ever; rail section modulus has been increased as much as 57%. Massive "K" or "X" brace crossmembers add to truck stamina; help keep you going years longer at least expense.



Chevy's new torsion-bar independent front suspension saves maintenance, increases work output. Independently suspended front wheels step right over bumps; tough torsion bar springs soak up shocks. As much as 58% of all objectionable road shock is absorbed before it reaches truck body, sheet metal or driver!

Chevy's easier riding rear springs help roll up profits. New variable-rate rear springs come in high capacities to handle huge payloads. Spring resistance adjusts automatically to cushion the load better.

CHEVROLET'S BIG NEW BUILD IS LIKE MONEY IN THE BANK FOR YOU!

Here are just a few of the *many* ways in which Chevrolet's totally new build for '60 will work to build a bigger bank account for you. They show that a '60 Chevy means *profit* through longer life, less maintenance, easier working, outsized cargoes and extra economy! You'll find, too, that 1960's savingest truck *power* is Chevrolet's: famous economy 6's and efficient short-stroke V8's for light-duty models . . . high-power, high-torque V8's and tough, dependable 6's for the bigger trucks. It'll profit you to see your Chevrolet dealer about Chevy's big new build, sometime soon. . . . Chevrolet Division of General Motors, Detroit 2, Michigan.

1960 CHEVROLET STURDI-BILT TRUCKS

CHEVROLET

"CAN DO!" PERFORMANCE backed by "HAVE DONE" EXPERIENCE

THE MASSEY-FERGUSON 204 is the most versatile and maneuverable unit a city could own!

EQUIPPED WITH INSTANT REVERSE

The Massey-Ferguson Backhoe is the ultimate in efficiency. It has 14,000 pounds breakout power; permits unobstructed visibility; will dig flush to walls, fences, buildings. See why it is the most popular backhoe in America.

For a compact, versatile, and maneuverable utility rig there's nothing that compares with this 40-h. p. Massey-Ferguson 204 equipped with power-matched Loader and Backhoe. It has been put to the test by hundreds of public works departments and has always come through in the best "CAN DO" tradition. The 204 is equipped with Instant Reverse and Torque Converter. It saves time on every job . . . moves in and out of congested areas with ease . . . and speeds up cycle time between load and dump. Just a touch of the foot pedal and it changes direction of travel instantly and smoothly. The same pedal controls acceleration, and speeds are equal in both forward and reverse. It also features power steering, and is available with the famous Ferguson system. For loading, clean-up, backfilling, landscaping, or any of the hundreds of maintenance chores a city has to perform, it has no equal. Before you buy any industrial equipment, check into the full line available at your Massey-Ferguson Industrial dealer.

Why Wait? — Set a Date — We'll Demonstrate!

MASSEY-FERGUSON INDUSTRIAL DIVISION
Block 1000 South West St., Wichita 13, Kansas

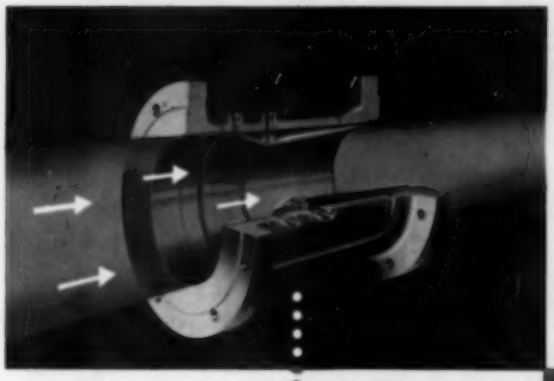
Producing Sizeable Power for the "Sensational 60's"

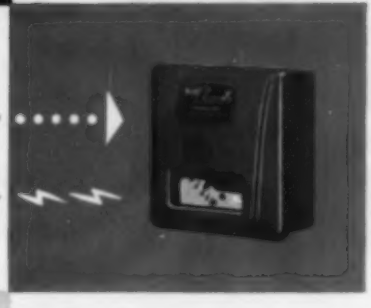
MF60-20

POSITIVE CONTROL OF MATERIALS IN MOTION B-I-F METERS FEEDERS CONTROLS

B-I-F COMPATIBLE COMPONENTS . . .

Increase efficiency and accuracy in INTEGRATED TELEMETERING SYSTEMS!





Builders-Providence time-duration telemetering systems . . . primaries, transmitters and receivers specifically designed and teamed for better measurement and control of

- flows
- pressures
- temperatures
- levels
- positions
- weights
- electrical quantities

Primaries . . . most complete line available . . . Venturi Tubes for highest accuracy, Dall Flow Tubes for minimum head loss, and wide selection of special tubes and nozzles to suit any requirement.

Transmitters . . . many Chronoflo types . . . individually designed to transmit flow, level, pressure, electrical quantities, temperature or similar functions over long distances.

Receivers . . . new modular construction permits building-block type assembly of unitized plug-in components for greater reliability, high enduring accuracy, high speed operation, high repeatability, and greater versatility.

B-I-F *Industries*

BUILDERS-PROVIDENCE • PROPORTIONEERS • OMEGA

METERS • FEEDERS • CONTROLS / CONTINUOUS PROCESS ENGINEERING

Remember . . . B-I-F offers single responsibility for complete systems. For full details, request literature TH-MS, free of charge. Write on company letterhead for B-I-F's new 52 Page Telemetering Handbook available at $2.00 per copy.

B-I-F Industries, Inc., 356 Harris Ave., Providence 1, R. I.

THE LOAD-PACKER® 600

UNMATCHED FOR PERFORMANCE IN SIX MONEY-SAVING WAYS

1. FASTEST OPERATION—Crew starts reloading in just 4 seconds... full cycle takes only 10 seconds.

2. GREATEST COMPACTION—Direct thrust compaction packs more per yard than any competitive unit.

3. BIGGEST LEGAL PAYLOADS—Biggest loads on any given chassis for two reasons. First, dead weight is cut to a minimum; second, telescopic hoist eliminates heavy sub-frames and improves weight distribution.

4. LARGEST LOWEST HOPPER—Big 1½ cubic yard, 74 inch wide hopper, plus low loading height.

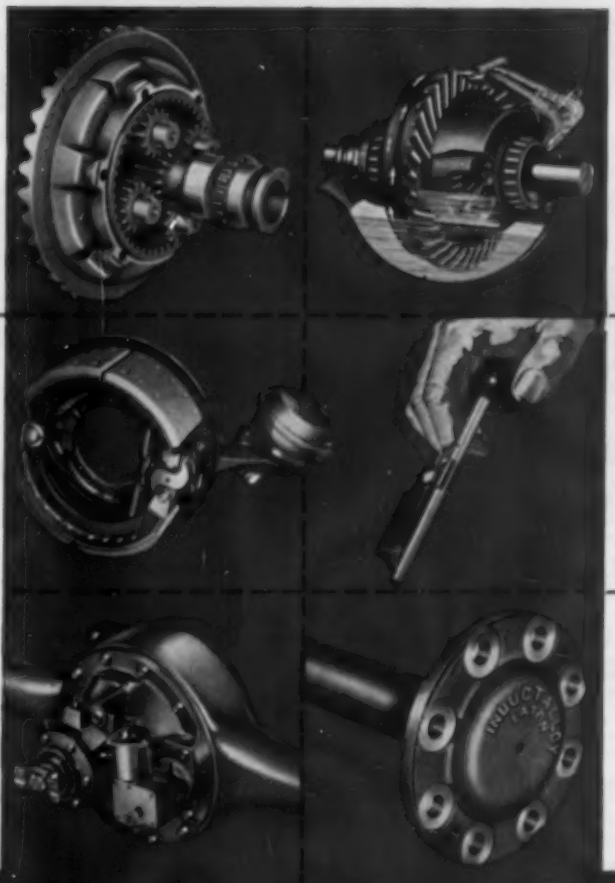
5. SAFEST, MOST DEPENDABLE—Controls are simple, foolproof. Operator has positive control. Fewer moving parts, less linkage, few adjustments.

6. GREATEST ECONOMY—Biggest hopper and fastest packing cycle cut fuel costs and equipment wear.

Find out more about the efficiency-engineered, BIG SIX performance of the Load-Packer 600 from your Gar Wood-St. Paul truck equipment distributor. Ask him to show you the colorful, sound film, "The BIG-6 Story" soon.

Gar Wood
INDUSTRIES, INC.
Wayne, Michigan
Richmond, California

Only Eaton 2-Speed Axles Have these Cost-Saving Features



PLANETARY GEARING

—distributes wear over four rugged, slow-moving planetary gears, resulting in lower unit stress, reduced maintenance, and longer axle life.

FORCED-FLOW LUBRICATION

—supplies positive lubrication to all moving axle parts, even at slowest vehicle speeds. Reduces wear; cuts repair bills.

SELF-CONTAINED AIR BRAKE

—makes quicker, safer stops. Simple design with fewer parts cuts relining time. Available on Eaton air brake models.

POWER SHIFT CONTROL

—provides quick, easy shifts. Drivers use right ratio for road and load; take full advantage of 2-Speed benefits.

EXTRA-RUGGED CONSTRUCTION

—of housing and all moving parts eliminates the possibility of harmful distortion or misalignment under full load; holds maintenance to a minimum.

INDUCTALLOY AXLE SHAFTS

—made of alloy steel, with Eaton's exclusive method of dual-hardening truck shafts; last up to 10-times longer; keep trucks on the road.

More Than 2-Million Eaton Axles in Trucks Today

Ask Your Truck Dealer for Complete Information

EATON

AXLE DIVISION
MANUFACTURING COMPANY
CLEVELAND, OHIO

Equipment and Materials for your PUBLIC WORKS PROGRAM

The engineering information in these helpful catalogs will aid you in your Engineering and Public Works programs. Just circle numbers you want on the reply card, sign and mail. This free Readers' Service is restricted to those actively engaged in the public works field of cities, counties or states.

NEW LISTINGS

Now You Can Switch One or Two Men to Other Work

216. . . . if you are doing bucket sewer cleaning with old-fashioned machines. The Flexible Truck-Loder eliminates dumping, shoveling and street cleaning. Debris goes direct from sewer to truck. Catalog 59-Z tells all about it. Address Flexible Inc., 3786 Durango Ave., Los Angeles 34, Calif., or check the card.

No Idle Trucks with these Spreaders

217. New 8-page catalog gives features, specifications, users' statements on the Fox Mountable spreaders, equally good for sand, cinders, chips, salt, calcium chloride. Designed for one-man operation and year-round use. Wide widths and high speeds. Mounts or demounts in 15 minutes. Write Fox River Tractor Co., Box 469, Appleton, Wisc., or check our card number.

The Name is Clark

229. . . . The product is a line of Tractor Scrapers, Dozers and Shovels that make your operators happy with powerful heavy-duty equipment, engineered for fast performance on tough jobs. For full details address Clark Equipment Co., Construction Machinery Div., Benton Harbor, Mich., or check our card.

"Work Horse" Power via Wisconsin Engines

233. 3 to 56 hp. heavy duty air cooled engines, ready to go to work when you get them, are described in Bulletin S-249. This bulletin covers power and weight specifications, dimensions and installation data for the entire line. Write Wisconsin Motor Corp., Milwaukee 46, Wisc. direct, or check our card.

Save on Winter Ice Control Cost

237. . . . with the faster-working salt described in this new Bulletin B-1159S. Tells what this salt will do and why, and where to get it. Also the bonus you get from using salt for summer road stabilization projects. Address Morton Salt Co., Industrial Div., 110 N. Wacker Drive, Chicago 6, Ill., or use our card.

Packaged Engineering Data on Packaged Lift Stations

238. Help on sewage pumping problems is available in new bulletins which cover packaged pump stations, pneumatic lift stations and pneumatic ejectors. Write to Tex-Vit Supply Co., Mfg. Div., Mineral Wells, Texas, or check the card.

Slide Rule Plans Hazard Warnings Placement

265. This clever adaptation of the slide rule principle tells at a glance practically every factor governing the placement of signs, flagmen, traffic cones, barricades, lanterns, torches and flashers. To get the Dietz Hazard Warning Planner, address Dept. RB, R. E. Dietz Co., Box 1214, Syracuse 1, N. Y., or check the reply card.

Easy Way to Get Up-to-date on Culvert Pips

269. This new illustrated catalog CMS-5859 is full of facts and ideas that you can use. Gives data on joints, fittings and proper installation methods. Your catalog shelves will be less than complete without it. Address Armco Drainage and Metal Products, Inc., Middletown, Ohio, or just check our card.

MORE LISTINGS ON PAGES 38 TO 54

A Quick Comparison of Water Meters Helps

274. That is the purpose of the new bulletin describing the newest accomplishments in water meter design and manufacture. With it comes a Condensed Catalog of the Rockwell line. Ask for Bulletin No. W-811 from Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa., or check the card.

More Attractive than Crab Grass

278. . . . is this new grounds-maintenance booklet on Ford Tractors just issued. 18 action photos in color emphasize the versatility of these tractors in powering mowers, snow removal and general clean-up operations by all Public Works departments. Write Industrial Sales Div., Ford Motor Co., 2500 E. Maple, Birmingham, Mich., or check the card-number.

Control Weeds 'Round the Calendar

291. Better than spasmodic, seasonal attacks. This beautiful color-illustrated booklet is full of facts, help and hints about how to win the war on weeds everywhere and all the time. Write Geigy Agricultural Chemicals Div., Saw Mill River Rd., Ardsley, N. Y., or check our card-number.

Do You Know the Value of the V-Notch?

295. A new booklet tells what you want to know about how chlorine feeding can be made as regular and precise as the sunrise. Ask for "The V-Notch Story" direct of Wallace & Tiernan Inc., 25 Main St., Belleville 9, N. J., or check the card-number.

How to Get Better Concrete Bonding

307. Whether your problem is bonding old to old concrete, new or fresh concrete to old concrete, or remedial patching and anti-skid surfacing, there is help in a very new informative booklet on Thiokol liquid polymer epoxy concrete adhesive. Just write Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton 7, N. J., or check our card number.

Roots Seeking Entry into Your Sewers

315. . . . give up in despair when confronted with pipe joints made with Atlas JC-60 plastic base sewer joint compound. Engineering data are presented in Bulletin M20-3. For your copy write Atlas Mineral Products Co., Mertztown, Pa., or check our card.

Make Concrete and Masonry Cutting Easier

325. . . . and faster with the right equipment. Saws and drills are shown in a new 4-page color folder. Address Truco Masonry Drilling Division, Wheel Truing Tool Co., 3200 W. Davison, Detroit 38, Mich., or check the number on our card.

For Fast, Accurate, Economical Traffic Line Painting

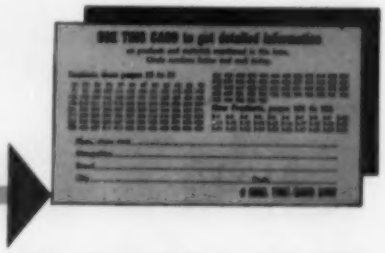
327. The Mark-Rite Line Marker can stripe one, two or three lines, in one or two colors, with skip lines or solid. Check all features by getting new 12-page brochure from Universal Manufacturing and Sales Co., 424 West Redondo Beach Blvd., Gardena, Calif., or check the card-number.

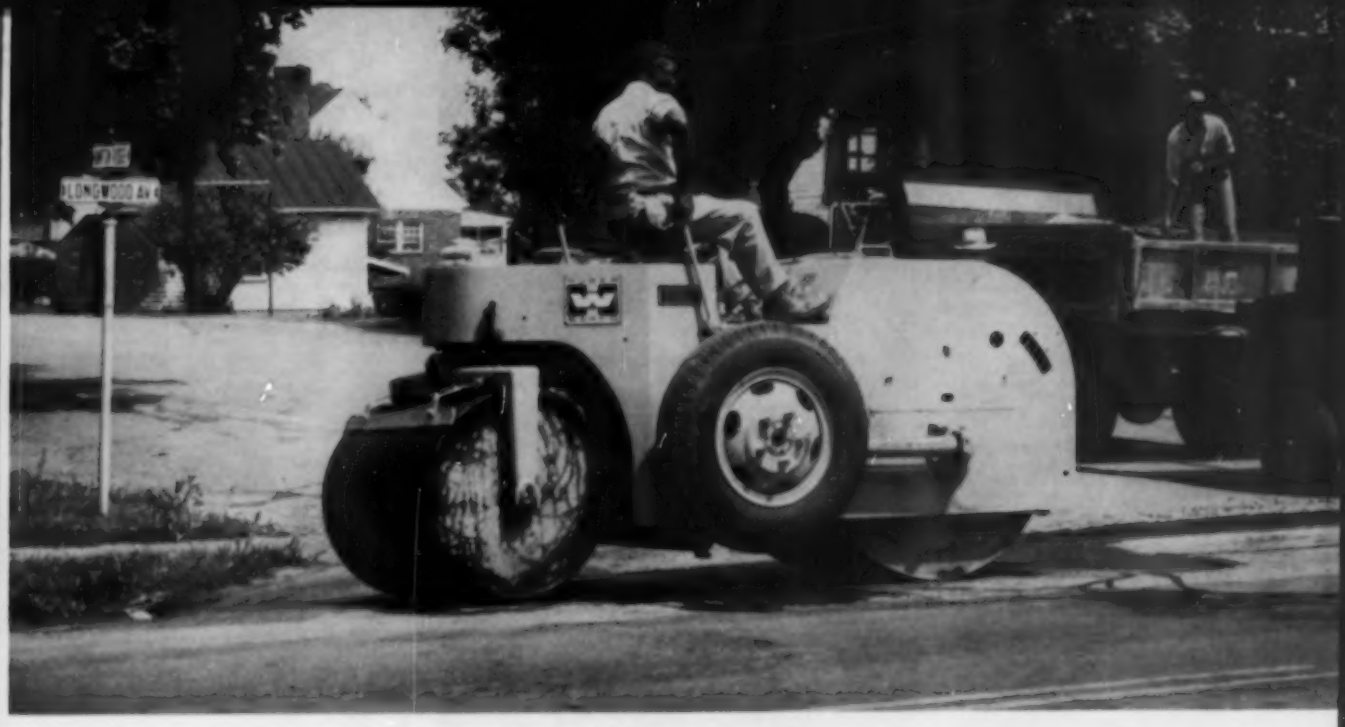
Look at the "Commando," The Prime-Mover Power Package

368. Here is a one-investment piece of equipment that can cut your equipment inventory and costs 'way down. The "Commando" is presented as a single basic prime mover for 1,001 jobs. Does almost any utility job, from bulldozing and snow plowing to tractoring and backhoeing, with one piece of super-versatile equipment. Get folder CI-360 from Ottawa Steel Div., Young Spring & Wire Corp., Ottawa, Kans., or check the card.

When You Need Sand Blasting There's Nothing Like the Jet-Blaster

398. . . . for economy, efficiency and ease of operation. As first step toward making old surfaces look new get latest bulletin by addressing Air Placement Equipment Co., 1000 West 25th St., Kansas City 8, Mo., or check number on the card.





CITY OF BEDFORD, VIRGINIA uses its Huber-Warco 4-6 ton retractable wheel roller on all types of compaction work. Charles Reid, superintendent of public works, likes the ease with which the roller can be transported from job to job on patching work.

HUBER WARCO

HUBER-WARCO *tandem rollers*

3-5 ton 4-6 ton retractable 5-8 ton 8-10 ton 8-12 ton 10-14 ton

DRIVE FEATURES — Water-cooled torque converter cushions against shock. Tailshaft governor maintains desired speed regardless of grade for easy, accurate control. Two-speed transmission* prevents loss of efficiency in tailshaft governor or hydraulic steering at all rolling speeds.

KING OF KINGPINS — Complete freedom from kingpin and swivel pin looseness. Tapered roller bearings permit "like-new" adjustment. No road scuff in reversing. Kingpin and housing easily removable.

CONTROL FEATURES — Variable hydraulic control adjusts to steering "feel" best for operator. Dual controls. Parking brake system completely independent.

PERFORMANCE PLUS — Work within less than 2 inches of buildings. Unsurpassed visibility. Final drive mounted in the frame, not on it, for longer shaft, gear and bearing life.

*Except for 3-5 ton and 4-6 ton models.

A trusted product name backed by respected distributor names from coast to coast

MOTOR GRADERS

Standard transmission models from 83 to 160 H.P. Torque converter and power shift transmission models from 102 to 195 H.P.

TANDEM ROLLERS

3-5 Ton • 4-6 Ton Retractable • 5-8 Ton • 8-10 Ton • 8-12 Ton • 10-14 Ton

3-WHEEL ROLLERS

10-Ton • 12-Ton • 14-Ton Standard Weight 10-12 Ton • 12-14 Ton Variable Weight

MAINTAINER

M-52 — 45½ H.P. Attachments are Lift-Loader, Broom, Bulldozer, Patch Roller, Scarifier, Snow Plow, Berm Leveler

HUBER-WARCO COMPANY Marion, Ohio, U.S.A.

To order these helpful booklets check the reply card opposite this page.

NEW LISTINGS (Cont.)

Cut Costs on Roofs with New Method

338. Wide spans on Public Works buildings 40 to 1,000 feet are now possible without high costs with this new, tested DUBL-PANL method. Here is something that will repay investigation. New color-illustrated booklet A.I.S. File No. 17 available now. Write Building Div., Behlen Mfg. Co., Columbus, Nebraska.

Do You Add Calcium Chloride to Your Salt?

367. Attractive new booklet tells of the powerful aid calcium chloride extends to salt. Gives recent factual histories on Ohio Turnpike and other high-speed northern highways. Get the book now and be ready for next winter early. Ask Calcium Chloride Institute, 909 Ring Bldg., Washington 6, D. C. for "Calcium Chloride and Salt Mixtures," or check our card.

Who Says Water Tanks Stand Still?

378. Not in design they don't. For the latest developments in Horton steel reservoirs and standpipes it is time now to write for new bulletin, liberally illustrated and with table of standard tank dimensions, to Chicago Bridge & Iron Co., 332 South Michigan Ave., Chicago 4, Ill., or check the card-number.

Got Tough Sewer Problems?

390. Then get new 4-page folder showing the solutions offered you in corrugated metal pipe with smooth asphalt lining. Contains descriptions and guide specifications along with loading tables. Engineers will find it particularly useful. For "Republic Free Flow Sewer Pipe," Booklet 1101, address Republic Steel Corp., Advertising Div., 1441 Republic Bldg., Cleveland 1, Ohio, or check our card-number.

How to Select and Specify Water Stops

406. Comprehensive application and installation data on all types and sizes of water stops are covered in valuable Bulletin MRG-473. Address The Gates Rubber Co., 999 South Broadway, Denver 17, Colo., or check number on the card.

For Fast Hole-Digging

394. . . . discard old fashioned ideas and tools and look into this new, highly maneuverable hydraulic digger that paces utility, guard rail and similar earth boring operations with amazing speed and economy. Hole diameters to 24", depths to 75 feet. New bulletin D-6 tells how good it is—and why. Address Mobile Drilling, Inc., 960 N. Pennsylvania St., Indianapolis 4, Ind., or use our card.

"Increases Batch Plant Production from 250 to 800 cu. yds. per day"

396. This promise is contained in new engineering reference manual describing what is called "Progressive Capacity Batching." An eye-opener for the man who wants to up his concrete batch capacity without discarding useful equipment along the way. Free manual available from the Boardman Co., P. O. Box 1152, Oklahoma City, Okla., or check our card-number.

Help on Welding and Cutting Jobs

402. New 36-page catalog on gas welding and cutting hand torches, outfits, tips and accessories includes specification charts and all necessary pertinent information on general purpose and special gas welding and cutting. Write Air Reduction Sales Co., 150 East 42nd St., New York 17, N. Y., or check the card.

Be Modern in Your Lighting Standards

423. In this field new designs, new materials, new ideas are emerging fast. To keep abreast you will want these latest folders LS-29 and LS-30 on steel and aluminum pole standards, respectively. Includes data also on brackets, proper heights, and other pertinent matters. Address The Union Metal Mfg. Co., 1432 Maple Ave., N.E., Canton 5, Ohio, or check our card-number.

Controls for Water and Sewage Pumps

428. Condensed data sheet gives you valuable information on applications and operation of Roto-Trol controls. Before you design automation in pump service, write Healy-Ruff Co., 2255 University Ave., St. Paul 14, Minn., or check card number.

A Flat Statement About Round Tanks

434. The title of a new finely illustrated booklet is "Steel Tanks Store Water Best." It gives pictures, essential data, and a fine impression of strength, water-tightness and beauty combined in sturdy structures. For your copy write Steel Plate Fabricators Association, 105 W. Madison St., Chicago 2, Ill., or check our card.

A New Note in Swimming Pools

445. . . . is sounded by the new Chester Swimming Pool catalog. In five colors, it describes and illustrates typical all-aluminum pools up to 50 meters in length, suitable for municipalities, communities and clubs. Contains valuable pool-planning information for you and for your citizens. To receive it write Dept. P, Chester Products Inc., Belle Ave. and B&O RR, Hamilton, Ohio, or circle number on card.

Easier Road Widening and Trench Filling

451. Efficient Power-Pack Conveyor equipment and methods for filling trenches and doing curb, shoulder and maintenance work are described in a handsome booklet. Find out how these machines can lighten your labors and lower your costs. Write Power-Pack Conveyor Co., 836 E. 140th St., Cleveland 10, Ohio.

For Better Municipal House-Keeping

452. . . . you will want to know about the "Load Lugger" system of refuse collection, storing and disposal. It mechanizes a growing problem, cuts man power requirements, speeds collections and pays its way. To get the details just write for Bulletin 457 to Load Lugger, Ingersoll Kalamazoo Div., 1810 N. Pitcher St., Kalamazoo, Mich., or circle number on card.

End Traffic Streaks on Traffic Paint

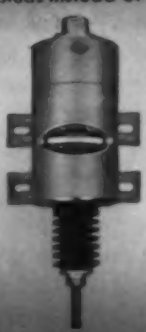
453. Learn how you can turn traffic loose on pavements painted ten minutes before with Parlon chlorinated rubber base traffic paint, with quick drying, long-time toughness and abrasion-resistance. Booklet that tells more is available from Cellulose Products Dept., Hercules Powder Co., Wilmington 99, Del.

Continuous Duty

D.C. SOLENOIDS

with A N CONNECTOR

Synchro-Start MODEL SD-A SOLENOID has an exceptional amount of power over a long stroke with a standard A N Connector. The sealed casing protects this solenoid from seepage of dust and liquids. This solenoid is also available with standard terminal studs instead of the A N Connector (Model SD).



Specifications—SD-A can be furnished in all standard and special voltages up to 115 Volts D.C.

10 lb. pull over 1½ inch stroke.

Power consumption, 550 Watts pulling and 8 Watts holding.

Housing dimensions, 4⅛" x 2⅛".

Further information upon request.

SYNCHRO-START PRODUCTS

INCORPORATED

NETCO CATCH BASIN CLEANER

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March 1960

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National Association of Corrosion Engineers
Memorial Auditorium
Dallas, Tex., Mar. 14-18

Illinois Section, AWWA
Pick-Congress Hotel
Chicago, Ill., Mar. 16-18

23rd Annual Short Course for Superintendents and Operators of Water and Sewerage Systems
Louisiana State University
Baton Rouge, La., Mar. 16-18

New England Section, AWWA
Statler Hotel
Boston, Mass., Mar. 17

Mississippi Valley Conference of State Highway Departments
Edgewater Beach Hotel
Chicago, Ill., Mar. 17-19

Southeastern Section, AWWA
DeSoto Hotel
Savannah, Ga., Mar. 20-23

Northwest Highway Engineering Conference
Oregon State College
Corvallis, Ore., Mar. 22-25

West Virginia Section
Water Pollution Control Federation
Hotel Pritchard
Huntington, W. Va., Mar. 23-24

West Virginia Section, AWWA
Hotel Pritchard
Huntington, W. Va., Mar. 24-25

Association of Highway Officials of the North Atlantic States
Bellvue-Stratford
Philadelphia, Pa., Mar. 30-Apr. 1

New Jersey Section
Water Pollution Control Federation
Traymore Hotel
Atlantic City, N. J., Mar. 30-Apr. 1

New York Section, AWWA
Sheraton-Binghamton Hotel
Binghamton, N. Y., Apr. 5-7

Kansas Section, AWWA
Broadview Hotel
Emporia, Kan., Apr. 20-22

Nebraska Section, AWWA
Cornhusker Hotel
Lincoln, Nebr., Apr. 20-22

California Section, AWWA
Mark Thomas Inn
Monterey, Calif., Apr. 22

Virginia-DC-Maryland Chapter, APWA
George Mason Hotel
Alexandria, Va., Apr. 22-23

Kansas Section
Water Pollution Control Federation
Broadview Hotel
Emporia, Kan., Apr. 23-24

Montana Sections, AWWA &
Water Pollution Control Federation
Northern Hotel
Billings, Mont., Apr. 29-30

Arizona Section, AWWA
Pioneer Hotel
Tucson, Ariz., Apr. 29-30

Purdue Industrial Waste Conference
Purdue Memorial Union Building
Lafayette, Ind., May 3-5

Pacific Northwest Section, AWWA
Benson Hotel
Portland, Ore., May 4-6

National AWWA
Americana Hotel
Bal Harbour, Fla., May 15-20

Central California Chapter, APWA
Hacienda Motel
Fresno, Calif., May 16-18

National Society of Professional Engineers
Statler Hotel
Boston, Mass., Jun. 8-11

Pennsylvania Sec., AWWA
Hilton Hotel
Pittsburgh, Pa., June 14-17

American Public Works Association
The Coliseum
New York, N. Y., Aug. 14-17

Institute of Traffic Engineers
Edgewater Beach Hotel
Chicago, Ill., Sep. 11-15

Water Pollution Control Federation
Philadelphia Sheraton Hotel
Philadelphia, Pa., Oct. 2-6

American Public Health Association
San Francisco, Calif.
Oct. 31-Nov. 4

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Readers' Service Dept.

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BANTAM works on 750' x 635' sewage oxidation pond, 14' deep tapering to 5'. 135,000 yards completed in five months with BANTAM and one other bigger machine. BANTAM is the faster of the two, according to Picayune city manager.

"handiest rig we own"...

Says City Manager
A. J. Read, Picayune, Miss.

Fast-swinging, ½-yard dragline bucket dumps another load. With BANTAM high-flotation crawler design, you can travel easily over all ground conditions—go anywhere to do the job better, faster and at lower cost.

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Picayune gets big returns from its BANTAM investment. The C-350 works on all the jobs necessary to keep a thriving municipality going: road work, materials handling, sewer line extensions, cleanout maintenance on drainage canals, etc. The BANTAM has been working constantly nine hours a day since its purchase, with practically no time out for maintenance. As A. J. Read, city manager, puts it: *"The BANTAM is a good all-around machine for our purposes. It's the handiest rig we own."*

Job-try a new BANTAM

The C-350 is only one of three BANTAM models that can speed all your construction and excavating jobs at real savings to you. All BANTAMS work with 11 versatile attachments to handle an amazing range of jobs. Find out how you can save money with a versatile, job-speeding BANTAM 350.

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NEW LISTINGS (Cont.)

Motor Graders
Can be Different . . .

437. Four models, from 83 to 160 hp, are described in new bulletin on Huber-Warco Motor Graders. Filled with data to help you select the best in graders. For Bulletin HWG-569 just write Huber-Warco Co., P. O. Box 501, Marion, Ohio, or circle number on card.

Now a Hydraulic Power Hammer!

471. Look into this pioneering equipment that speeds operations, adds convenience. Weighs 85 lbs. Compact, portable hydraulic power unit matches the hammer. Write for circulars to Henry Mfg. Co., Inc., 1700 N. Clay, Topeka, Kans., or check card-number.

Complete Package
Dravo Incinerator Plant

473. The Dravo incinerator includes automatic refuse and raw sewage sludge handling combustion controls, water wall furnace, ash disposal system, flue gas scrubber and everything necessary for the efficient operation of the plant with minimum personnel. Write for full information to Dravo Corp., Dravo Building, Pittsburgh 22, Pa., or check the reply card.

Locate Water Leaks
Quicker and Easier

476. An aquaphone that requires no mechanical connection between probe and diaphragm to break or cause of trouble is described fully in literature from Aqua Survey & Instrument Co., 2012 Leslie Ave., Cincinnati 12, Ohio.

Descriptive and Performance Data
on Sump and Sewage Pumps

483. Performance tables, selection charts, characteristic curves and architect's and engineer's specifications of Pacific sump and sewage pumps are included in complete catalog from Pacific Pumping Co., 9201 San Leandro St., Oakland 3, Calif., or by checking the reply card.

Gradall Earth Moving
and Construction Machine

486. The multi-purpose Gradall is described in catalog available from the Gradall and Hopto Divisions, The Warner & Swasey Co., Cleveland 3, Ohio. Check the reply card for description of machine, applications and specifications.

Even Skunks Envy These White Lines

487. . . . as put down on pavements by Mark-Rite striping machines. A type for every job—one, two or three lines, one or two colors. For full data on these versatile machines get catalog from Unimasco, Inc., 426 W. Redondo Beach Blvd., Gardena, Calif., or check the card.

Best Friend of
Your Fire Insurance

489. . . . can be a Peerless fire pump for independent fire protection. What it will do both for protection and in lowering your insurance rates is discussed in a Bulletin B-1500. Peerless Pump, Hydrodynamics Division, 2005 Northwestern Ave., Indianapolis 8, Ind.

A New Note in
Waterworks Brass Goods

492. The Hays line covers everything from curb stops to tapping machines. Beautifully illustrated catalog is packed with information to help you buy the best. To get your copy write Hays Mfg. Co., Erie, Pa., or check the card.

Sewer Joints that
Fight Infiltration

494. Sewer pipe joints that seal out roots and infiltration, fight exfiltration leakage at pipe joints, are offered you in Ram-Nek, a new rope form plastic jointing material for concrete pipe, cold-applied, and Root-Seal plastic base hot poured compound. Get the full story by writing K. T. Snyder Co., 4101 San Jacinto, Houston 4, Texas, or check the card.

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495. . . . registers a new high mark with the Hobbs Hyd-Pak 60 model. Gives lower loading height, watertight body, 3 "extra" yards all in one ultra-modern, proven piece of equipment. For details on this unit and a pick-up container system, address the Hobbs Hyd-Pak Division, 609 N. Main St., Fort Worth, Texas.

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500. . . . when you use "Safe-T-Cone" traffic guides. Flexibility of traffic control speeds pavement striping, eases traffic diversion. New features, new models, new uses are all described in literature of Radiator Specialty Co., Charlotte, N. C. Write direct or circle the reply card.

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515. Not any more! For full data on how chemical weedkillers for roadsides make a clean sweep of obnoxious growth get booklet on AMIZOL, from Amchem Products, Inc., Ambler, Pa. Circle their number on our card.

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Pipe Pushing and Pulling

517. Continuous-motion machine works all the time to keep pipe moving fast until it is through. Hand or air powered. Write for new folder to The Trojan Mfg. Co., 1112 Race Drive, Troy, Ohio, or use our reply card.

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518. . . . Hale pumps pump it out. The "Torrent" moves high volumes of water fast. For seepage and water that is "too thick to drink, too thin to plow" there's the Hale diaphragm line. Get latest bulletins from Hale Fire Pump Co., Conshohocken, Pa., or use the reply card.

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674. Rain Bird underground sprinkling system beats depending on the weather to keep your roadsides, parks and shrubbery green. Full and interesting details about the system, local dealers, etc. can be had from Rainy Sprinkler Sales Div., Peoria, Ill. Better still, check our card.

Manual on the Hersey
Disc Water Meter

521. Illustrations, descriptions and specifications of Hersey Water Meters are covered in Manual from Hersey-Sparkling Meter Company, 250 Elm Street, Dedham, Mass. Size ranges are 2" through 10". Disc, Compound (CI), Fire Service (FM) and Current (T) Meters. Check the reply card.

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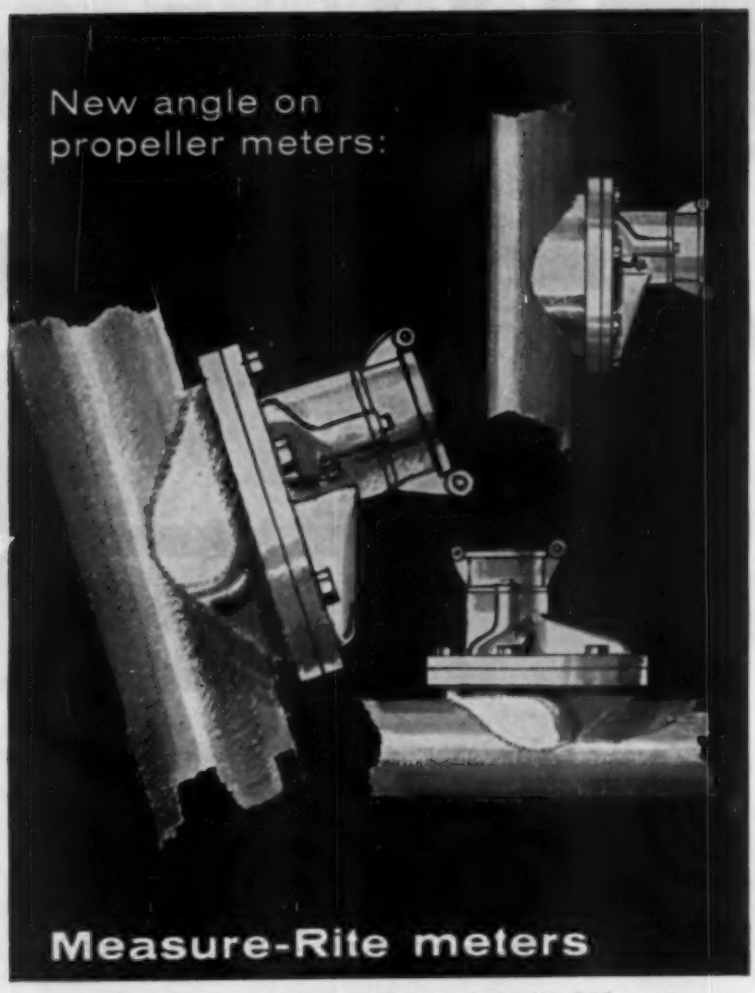
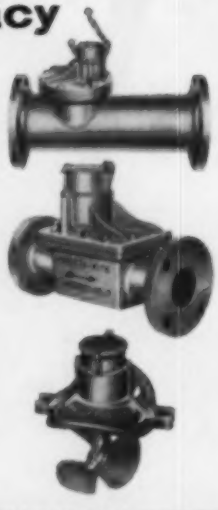


vary in mounting position but never in accuracy



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- **Free-flow design** — Puts the assembly forward, full centered in chamber to assure low loss of head.
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NEW LISTINGS (Cont.)

Handbook on How to Lay Concrete Pressure Pipe

324. Manual on concrete pipe laying instructions is available from Price Brothers Co., Dayton, Ohio. Check the reply card for information on how to dig the trench and handle the pipe, make the joint and the pipe bedding procedure.

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325. Put a Bantam in your life. On trenching, excavating, street and highway work this handy versatile crane-excavator obviates using larger equipment in many cases. Saves time and dollars. Get descriptive literature from Schield Bantam Co., 301 Park St., Waverly, Iowa or circle card-number.

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WATER WORKS

Do You Have An Independent Source of Electricity?

27. An independent source of electricity which will supply power for vital services when regular sources fail can be invaluable during emergencies. Check Kohler Bulletin KEP 56-1 which furnishes data that will help you select the plant best suited for your needs. Many models, 500 watt to 50 Kw, portable and stationary are described. Write the Kohler Co., Kohler, Wis., or use the reply card.

Catalog on Synchronous Motors and Controls

64. A 27-page Catalog B-7292 on synchronous motors and controls is well illustrated and contains motor selector charts, application data, and formulas for calculating power factor. For a copy write Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa., or check the reply card.

For Prompt Service Use The Reply Card

For Fast, Smooth Pipe Cuts

68. Descriptive literature on the Reed 4-wheel hinged pipe cutter which operates in close quarters, gives quick, easy right-angle cuts, and is available from Reed Mfg. Co., Erie, Pa. Check the reply card.

Efficient Coagulation With Ferri-Floc

69. Advantages claimed for Ferri-Floc as a coagulant include wide pH range, quick floc formation, manganese removal control of certain tastes and odors plus other aids in high quality water production. Check reply card for complete Ferri-Floc data. Tennessee Corp., Grant Bldg., Atlanta, Ga.

100 Page Book Helps Solve Water Problems

71. pH and Chlorine Control. A discussion of pH, Chlorine and Phosphate Control and descriptions of comparators for making colorimetric analyses. A 100 page booklet is available by checking reply card. W. A. Taylor & Co., 7304 York Road, Baltimore 4, Md.

Complete Package for Chemical Feeding

89. Pump-Tank combination ends a lot of old headaches, saves space and money, too. Comes ready to connect. Two-page bulletin 1800.20-1 tells all about this Proportioneers unit to simplify your chemical feeding. Address B-I-F Industries, Inc., 341 Harris Ave., Providence 1, R. I.

Before Taking Bids on Water Storage Tanks . . .

104. Learn more about GATX tanks, designed and fabricated by one of the nation's largest steel fabricators in accordance with AWWA specifications and municipal requirements. For detailed information, address Plate and Welding Div., General American Transportation Co., 135 So. La Salle St., Chicago 90, Ill., or circle our card number.

A fine point
in Badger
meter accuracy:
Old-style longer slot weakens chamber halves, with possibility of distortion
Exclusive dovetail thrust roller insert

cuts wear and noise at the water level

It's standard on all Badger Disc meters. Dovetail thrust roller insert fits vertically into the thrust roller slot to form a smooth track on which the roller rides countless times — quietly without wear. With the slot 77% shorter, original strength is retained and possible distortion in this area is eliminated.

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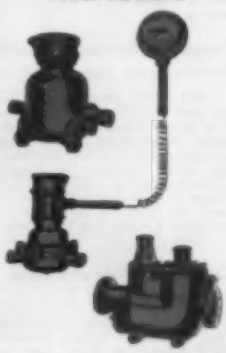

Badger Water Meters

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To order these helpful booklets check the reply card opposite page 38.

Rapid Sand and Pressure Filter Data

109. Rapid sand filters. A complete line of vertical and horizontal pressure filters, wooden gravity filters, and filter tables and other equipment. For engineering data, write Roberts Filter Manufacturing Co., 640 Columbia Ave., Darby, Pa., or check the reply card.

Get the Real Story on Plastic Pipe

116. Available at last in new 36 page handbook for engineers, filled with pertinent information on the use of KRALOY PVC plastic pipe, fittings and valves, with a wealth of collateral data that you will welcome. To get it free, address Kraloy Plastic Pipe Co., 4720 East Washington Blvd., Los Angeles 22, Calif., or use our card herein.

AWWA Fire Hydrants and Gate Valves

155. Above-ground maintenance Mueller AWWA improved fire hydrants and minimum maintenance Mueller AWWA non-rising stem gate valves are described in literature from Mueller Co., Decatur, Ill.

Now Every Municipality Can Own a Trencher

173. The low cost of the ARPS Trench Hog, a tractor-mounted ladder type trencher makes it profitable for many municipalities to own their own trencher. Be sure to investigate this versatile machine which digs trenches to 7 feet deep, 20 inches wide. Illustrated bulletin available from Arps Corp., New Holstein, Wis. Just check the reply card.

Engineering Data On Mechanical Joint C.I. Pipe

183. General specification, weights and dimensions of mechanical joint cast iron pipe and fittings are furnished in a 32-page booklet issued by Alabama Pipe Co., Anniston, Ala. Get this helpful data by checking reply card.

Lay Water Mains Faster With "Fluid-Tite" Couplings

184. Get permanent water-tight joints automatically with K & M "Fluid-Tite" couplings for K & M asbestos-cement pressure pipe. Full details on this faster installation and self-energizing couplings are available from Keasbey & Mattison Co., Ambler, Penna

Here's a New Note in Filter Cleaning Equipment

202. Just announced, a new S-Type Filter Arm that is reported to increase filter cleaning efficiency by 25 to 30%. Doubles the agitating impulses and improves your plant performance strikingly. Adaptable to present installations, too. Write Palmer Filter Equipment Co., Erie, Penn., or circle reply card.

Complete Catalog and Reference Data on Valves and Fittings

211. The entire M & H line of valves, fittings and accessories for water works, filtration, sewage disposal and fire protection are illustrated and fully detailed in Catalog 53 issued by M & H Valve & Fittings Co., Anniston, Ala. In addition to complete data on these products, there are many pages devoted to helpful engineering data. Every designer should have a copy.

Trenching Equipment Data Conveniently Assembled

212. The entire line of Cleveland trenching and backfilling equipment is now covered in a single bulletin, with material arranged for quick comparison of capacities, specifications and dimensions of all models. Twenty-four action photos graphically illustrate various job applications. Get Bulletin S-120 now for easy review of your trenching equipment needs. Just check the reply card or write to the Cleveland Trencher Co., 20100 St. Clair Ave., Cleveland 17, Ohio.

Clamps for Pipe and Hose and Steel Straps

219. Literature is available from Marman Div., Aeroquip Corp., Industrial Sales Div., 11214 Exposition Blvd., Los Angeles, Calif., on clamps to stop leaks on low and high pressure pipe, band clamps for hose, duct, pipe strap hanger and mounting bracket and stainless steel flags for identification purposes. Check the reply card.

Meters and Instruments For Water Works

224. An attractively arranged 20-page booklet issued by Hersey-Sparling Meter Co., 225 No. Temple City Blvd., El Monte, Calif., furnishes concise data on the full line of Sparling meters, indicator-totalizer-recorder instruments and other special instruments and controls. Check the reply card for your copy, or write for Bulletin 314.

Catalog on Dewatering Pumps

226. Centrifugal and diaphragm pumps for dewatering jobs are described in Catalog DP7 from The Jaeger Machine Co., 550 West Spring St., Columbus 16, O. Models, specifications and performance tables are included. Check the reply card.

Renew Pipe Performance With Cement Mortar Lining

322. Application of the Tate and Spunline process for cement mortar lining of existing pipe lines with a minimum of interruption of service is described, with diagrams, photographs and specifications in Catalog 15-58. Write to Pipe Linings, Inc. P. O. Box 457, Wilmington, Calif., or check the reply card.

Helpful Data on Water Meters

330. It is to the interest of every water works superintendent and engineer to have full data on dependable Badger water meters and related meter products. Complete data on all types of disc, turbine and compound meters, meter test equipment, yokes, strainers and alarm registers are supplied in an attractive binder by Badger Meter Mfg. Co., Milwaukee 18, Wisconsin.

Tips for Installing Orangeburg Pipe

336. Good practice for installation of Orangeburg pipe and fittings is outlined in an illustrated four-page bulletin made available by the Orangeburg Mfg. Co., Inc., 375 Park Avenue, New York 22, N. Y. Trenching and backfilling, pipe laying, cutting and connecting

Use The Reply Card

Helpful Data on Swimming Pools

364. Data on injector nozzles for complete recirculation, fittings for correct drainage and other useful information for pool design are covered in Manual SP issued by Josam Mfg. Co., Michigan City, Ind.

385-HP Engine For Standby Pumps and Generator Sets

372. International 385-hp compact heavy-duty 4-cycle, 6-cylinder engine is well illustrated in literature from International Construction Equipment, International Harvester Co., 180 North Michigan Ave., Chicago 1, Ill. Check the reply card for full specifications.

Many Fuels Will Power Enterprise Engines

395. New bulletin tells of economies and advantages of the Enterprise Engine "Dual Fuel" system. Ideal for stationary power plants, sewage treatment plants, and pumping stations. Address Enterprise Engine & Machinery Co., 18th and Florida Sts., San Francisco 10, Calif.

American Ductile Iron for Pipe, Tubing, Casing and Fittings

463. A 36-page illustrated catalog that describes the complete line of American Ductile iron products is available from American Cast Iron Pipe Co., P. O. Box 2603, Birmingham 2, Ala. Check the reply card for technical data including grades, specifications, dimensions and

Separation of Suspended Solids in Water and Sewage Treatment

512. A 24-page bulletin covering the complete line of clarifier and Oxidator® mechanisms is available from Process Engineers, Div. of The Eimco Corp., 634 South Fourth West St., Salt Lake City, Utah. Check the reply card for the basic types that cover a full range of tank sizes and load requirements, and special units for unusual conditions.

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Okla., Oklahoma City, P.O. Box 1024
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Ontario, Toronto 13, P.O. Box 160, Station H
Phone: Oxford 8-5551

Penn., Norristown, P.O. Box 230
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Penn., Pittsburgh 25, 3000 Grand Ave.
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Tenn., Memphis 8, P.O. Box 6833, Hollywd. Sta.
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Phone: Cedar 2-3308

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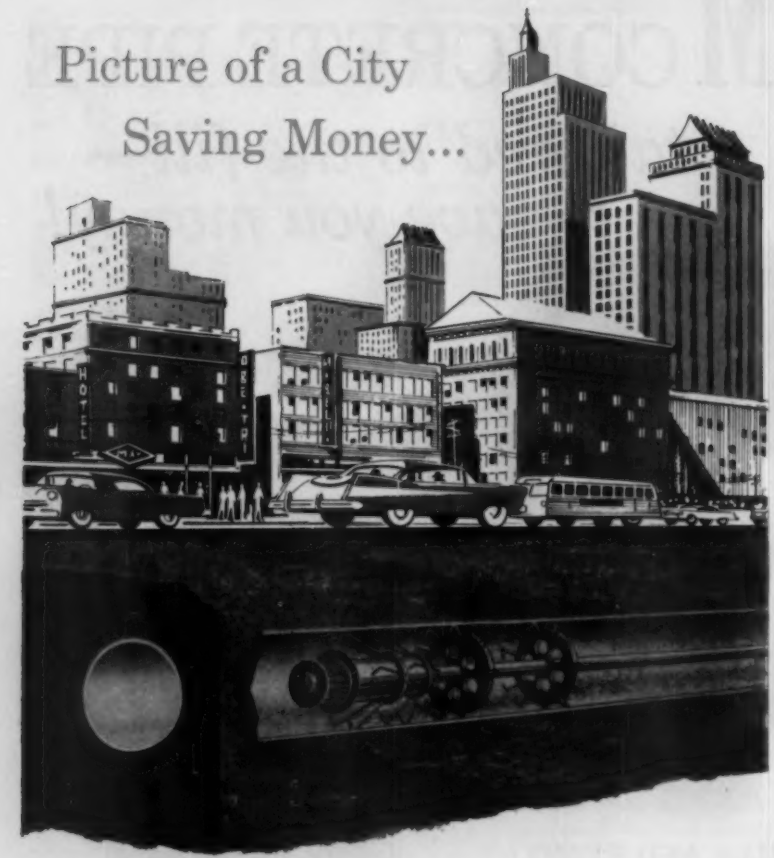

Spunline Relines Pipe Lines in-place without removing the pipe

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And traffic will move without interruption or inconvenience to the public.

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Subsidiary of American Pipe and Construction Co.

2414 East 223rd Street, Wilmington, California
P.O. Box 457 • Phones: SPruce 5-3273 — TErminal 5-8201
Rail Address, Pacific Electric, Watson, California

When You Measure Don't Lose Your Head

564. Head of water pressure, that is. There's a new propeller meter now, dedicated to just that. A new Bulletin, MR-105 tells how. You get it by writing Measure-Rite, Incorporated, a subsidiary of Badger Meter Mfg. Company, 701 S. Garfield Ave., Alhambra, Calif., or circling our card.

Coagulant Aids for Use in Municipal and Industrial Water Treatment

574. A 4-page bulletin describing Hagan coagulant aids points out how these aids speed up floc formation and also how they tend to produce larger and tougher flocs over wider pH ranges than coagulants alone. Check the reply card or write Hagan Chemicals & Controls, Inc., 323 Fourth Ave., Pittsburgh, Pa.

Technical Bulletins to Design or Check by . . .

600. for water and sewage plants. They are now available as No. 100 on Venturi tubes; No. 720 on supervisory control; No. 1003 on mechanically operated rate-of-flow and loss-of-head gauges; No. 1004 on pneumatic single and double indicating receivers; and No. 1225 on controlled closing air valves. For the set, write Simplex Valve and Meter Co., Lancaster, Pa., or circle our card number.

Play Safe with Automatic Controls

603. Remote engine and pumping controls of every sort are fully described in a series of bulletins offered by Synchro-Start Products Inc., 8151 N. Ridgeway Ave., Skokie, Ill. Write them or circle the above number on our card.

For Prompt Service Use The Reply Card

Streamlined and Modernized Fire Hydrants

607. Models, dimensions and advantages of the Eddy fire hydrant are covered in bulletin from the Eddy Valve Co., Waterford, N. Y. Check the reply card for complete details.

When the Frost is on the Meter

615. If it is an American frost-bottom meter freezing is no major problem. The replaceable center section breaks out leaving the mechanism undamaged. Bulletin 58 tells the story. Address Buffalo Meter Co., Inc., 2917 Main St., Buffalo 14, N. Y., or circle reply card.

Turn Your Water Meter Reading Inside-Out

671. The Visi-Meter is a remote recording and indicator system that eliminates the need of entering the home to read water meters. It records within an accuracy of 0.1 percent. Check the reply card or write Visi-Meter, Inc., 301 North 17th St., Kansas City, Kans., for literature.

Electronic Locators for Water Mains, Services, Valves and Boxes

677. Miniaturized line locator that is encased in a molded glass fibre container and has transistors that have a rated life of 70,000 hours and weighs only four lbs. when completely assembled is described in literature from Wilkinson Products Co., 3067 Chevy Chase Drive, Pasadena 3, Calif. Check the reply card.

Bulletin Covers Step-by-Step Action on the Water Problem

689. A step-by-step outline of action telling how the responsible citizens can help their officials extend and improve the local water system through more adequate rate structures on financing is covered in this bulletin available from Thos. F. Wolfe, Managing Director, Cast Iron Pipe Research Association, 3440 Prudential Plaza, Chicago 1, Illinois.

Mueller Drilling, Tapping and Inserting Machine

696. The Mueller B-100 double pressure chamber tapping machine makes faster taps, assures pressure tight connections and can be used by hand or with power. Check the reply card or write Mueller Co., Decatur, Ill.

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United Kingdom Affiliate: TYLORS OF LONDON LTD.

To order these helpful booklets check the reply card opposite page 38.

SEWERAGE AND WASTE TREATMENT

How to Make Better Sewer Pipe Joints

37. How to make a better sewer pipe joint of cement—tight, minimizing root intrusion, better alignment of joint. Permits making joints in water-bearing trenches. General instructions issued by L. A. Weston Co., Dept. P.W., Adams, Mass. Check the reply card.

Rust is a Loss; Lick it with Rust-Oleum

92. Here is a new 1960 catalog, filled with new facts on how to defeat ravages of rust, protect every metal, and beautify it too. Catalog is a work of art in full color. For your copy write for Form No. 259 to Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

What You Should Know About Trickling Filter Underdrains

39. Specifications for vitrified clay under drain blocks conforming to ASTM standards, suggestions for layouts and construction of trickling filter floors, dimensions of standard blocks, channel covers, angles and other fittings are available from the Trickling Filter Floor Institute c/o Editor, Public Works, 200 So. Broad St., Ridgewood, N. J. Check the reply card and we will forward your request.

Protective Lining for Concrete Pipe and Structures

131. T-Lock Amer-Plate is a tough, long-lasting acid-resistant vinyl sheet lining for concrete pipe and structures which are exposed to corrosive materials. T-shaped ribs pressed in the sheet are embedded in the concrete as it is poured to lock the lining permanently in place. Get full details from Amercoat Corp., South Gate, Calif., or check the reply card for illustrated folder.

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LEADERS IN MODERN ALL-STEEL WATERFRONT EQUIPMENT

Theory of Controlled Digestion With Floating Cover Tanks

88. In an excellent 40-page booklet, an authoritative discussion of digestion theory and practices, including design, operation and economics is presented by the Pacific Flush Tank Co., Chicago 13, Ill. Complete data are given on the use of floating covers, together with details on tank construction, piping and control chambers.

Packaged Underground Lift Station

124. Selection tables and detailed drawings of packaged underground lift stations with "Flush Kleen" sewage pumps are available in literature from Chicago Pump Co., 622 Diversey Parkway, Chicago 4, Ill. Check the reply card today.

A Short Course In Pipe Jointing

169. The story of rubber couplings for clay and concrete pipelines is graphically presented in the booklet "Pipe Enterprise", published by Hamilton Kent Mfg. Co., Kent, Ohio. Detailed description of pipe jointing methods; photos showing jobs where Tylox gaskets met the need for easily assembled permanently tight joints installed under all conditions; and a report on the development, manufacture and outstanding features of the compression type gasket make this booklet valuable to every engineer and contractor. Check the reply card.

Get Data Now on This Catch Basin Cleaner

198. Simple powerful pneumatic bucket is featured by Netco Catch Basin Cleaner. Folder 33A gives details and illustrates operation of complete self powered truck mounted unit, Netco Div., Clark-Wilcox Co., 118 Western Ave., Boston 34, Mass. Check the reply card.

Use The Reply Card

Dependable Engines for Sewage Treatment Plants

227. Climax Sewage Gas Engines are available for continuous duty operation to drive pumps, blowers or generators in a range of sizes from 40 to 250 HP. Use the handy reply card to obtain complete details and literature from Climax Division, Waukesha Motor Co., Box 379, Waukesha, Wisc.

Foxboro Magnetic Flow Meter

238. The Foxboro magnetic flow meter measures water and wastes electrically, without any line restriction. No loss of head, no fouling, even with slurries. For detailed illustrated Bulletin 20-14B check the reply card or write The Foxboro Co., Foxboro, Mass.

How to Dispose of Sewage and Industrial Sludges

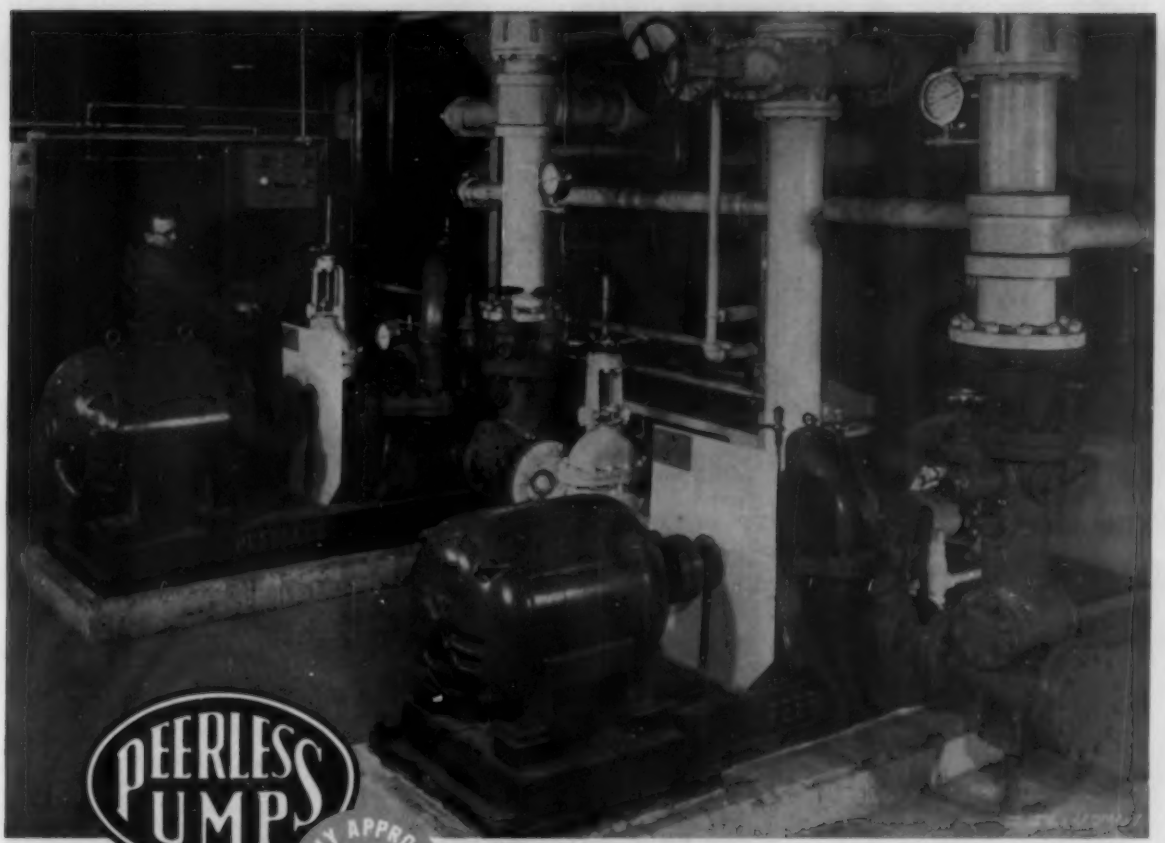
281. Get full information on the C. E. Raymond System of combined incineration and sludge drying providing high temperature deodorizing for nuisance-free sludge disposal. Flexible layouts fit large and small communities. Use handy reply card or write Combustion Engineering Inc., Raymond Div., 1132 W. Blackhawk St., Chicago 22, Illinois.

Amvit Mechanical Jointed Clay Pipe

298. The new Amvit jointed vitrified clay pipe in sizes 4 through 24 inches with the true "built in" mechanical joint ready for immediate and easy installation is infiltration and root-proof. Offers better flow and less maintenance and permits deflection and absorbs shocks. It is furnished on all standard fittings and permits immediate backfilling and testing. For literature write to American Vitrified Products Co., National City Bank Building, Cleveland, Ohio, or check the reply card.

Clean Sewers Cost Less Than New Ones

334. Here is news on 1960-models sewer-cleaning equipment that can keep money in your municipal pocket. To get latest literature on the O'Brien line just write O'Brien Manufacturing Corp., 5632 Northwest Highway, Chicago 46, or check the card.



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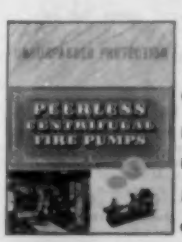

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317. Dimension and capacity tables for pneumatic float or electrode controlled ejectors, cast iron or welded steel, covering flow ranges of 20 to 600 gpm, including all information necessary in design are given in Bulletin No. KSM-2 3/58. Check the reply card or write Komline-Sanderson Engineering Corp., 101 Holland Avenue, Peapack, N. J.

Manual on Construction Castings

462. This 168-page Manual covers catch basin inlets and traps, building castings, manhole covers and steps, flap valves, wheel guards, drainage grates and many other construction and maintenance castings. Check the reply card or write Neenah Foundry Co., Neenah, Wisc., for your copy.

End Sewage Pumping Unhappiness

480. This new folder shows how others have done it, and why. It can be your road-map to satisfaction through "High and Dry" self-priming sewage pumps. Address The Gorman-Rupp Co., Mansfield, Ohio, or circle our card.

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601. N.P.R.C. has mobile-mounted equipment and trained personnel ready at all times for routine sewer cleaning jobs or specialized service. Write National Power Rodding Corp., 1000 South Western Ave., Chicago 12, Ill., or check the reply card for services available from this company.

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Manual on Solving Drainage Problems

645. An 80-page Manual on the problems of drainage and drainage materials is available. Design section includes determining culvert lengths and sizes, run-off calculations, excavation of base and backfilling data. Check the reply card or write Bethlehem Steel Co., Bethlehem, Pa., for the third revision of this valuable book containing new tables for evaluating flow fraction.

Catalog on Steel Grating

645. New ideas in flooring, walkways, stair treads, platforms and shelving are covered in Catalog 2527R available from Blaw-Knox Co., Dept. W., Pittsburgh 38, Pa. Check the reply card for information on choice of cross bar and bearing bar designs and spacings.

Reinforced Concrete Pipe For Culverts and Sewers

672. Elliptical Lo-Hed and Hi-Hed pipes, round pipe and flat base pipe are described fully in literature from American-Marietta Co., Concrete Products Div., 101 East Ontario St., Chicago 11, Ill. Headwall details, discharge curves, hydraulic capacity tables and hydraulic properties are included. Check the reply card.

BUSINESS ADMINISTRATION

If You are Considering a Bond Issue Check with Chase Manhattan

236. For details on bond issues for any municipal or governmental unit, write The Chase Manhattan Bank, 40 Wall St., New York 15, N. Y. Check the reply card.

Monthly Time and Cost Record Book

249. To assist owners in determining the cost of owning and operating equipment Caterpillar Tractor Co., News Service, Peoria, Ill., has prepared a 24-page monthly time and cost record book. Twelve sets of pages are included on which to record day by day machine expenses for an entire year. Check the reply card for your copy.

STREETS AND HIGHWAYS

Many New Construction Techniques . . .

35. are now possible through use of new Sika epoxy compounds for **bonding, patching,** joint and crack sealants, and coatings for concrete, and for resurfacing or pavements. Get new bulletin SEC 759 from Sika Chemical Corp., 35 Gregory Ave., Passaic, N. J. or use our card.

How to Prepare and Maintain Roadways With Calcium Chloride

43. "The Calcium Chloride Road," is the name of a new 24-page two-color catalog issued by the Columbia-Southern Chemical Corp., 632 Fort Duquesne Blvd., Pittsburgh 22, Pa. Included are sections on dust control, gradation, placing and mixing materials and shaping. General information on spring, summer and fall maintenance is also provided. Check the handy reply card.

Got to do Asphalt Mixing or Patching?

118. Whatever the job, speed and simplify your work with modern Wylie equipment for hot or cold paving materials. As the first step to improved performance get new data from Wylie Mfg. Co., 5926 N.W. 39th St., Oklahoma City 12, Okla., or use the reply card.

How Accurate Boring Speeds Underground Pipe Installations

128. Interesting charts showing earth boring costs, speed and accuracy for holes from 2½" to 14½" diameter and up to 80 feet long are included in 16-page Catalog No. 8 issued by Hydrauger Corp., 601 Market St., San Francisco 5, Calif. Specifications and general operating instructions are also covered.

Chip Dollars from Your Overhead With Fitchburg Chippers

160. Detailed cutaway drawings, specifications, diagrams, charts and money-saving reports and experiences are covered in catalog available from Fitchburg Engineering Corp., Dept. PW, Fitchburg, Mass.

Compact Wheel Tractor Makes Maintenance Jobs Easy

172. Rugged and powerful yet exceedingly low in cost, the Speedex Model S23 tractor with 9 hp engine will work for you all year around on park and yard maintenance chores. Attachments include gang and rotary mowers, cutter bar, front and rear blades. Check advantages of this versatile machine by writing Speedex Tractor Co., 367 N. Freedom St., Ravena, Ohio, or check the card.

Catalog on Tractor-Driven Tailgate Spreader

182. Highway Equipment spreader spreads in the echelon pattern for ice control and the blanket pattern for seal coating. For literature write Highway Equipment Co., Dept. H41 616D Ave. N. W., Cedar Rapids, Iowa.

Need Tractor Versatility?

220. Two bulletins tell of various uses—several of them surprising—to which Oliver 550 All-Purpose wheel tractors can be put. Much valuable information is yours for the asking of the Oliver Corp., Ind. Div., 19300 Euclid Ave., Cleveland 17, Ohio., or circle this number and mail card.

Illustrated Specifications on Brush and Limb Disposal

222. A new booklet on the modern approach to the brush problem shows how an Asplundh chipper reduces bulky branches and brush trimmings to chip size for mulch or easy removal. Write Asplundh Chipper Company, 501 York Road, Jenkintown, Pa., or use the handy reply card.

Rubber Roads Are Now a Reality

230. Ramflex, a free-flowing, devulcanized rubber specially prepared to be used in combination with asphalt for highway paving applications is described in illustrated catalog from U. S. Rubber Reclaiming Co., Inc., P. O. Box 365, Buffalo 5, N. Y. Check the reply card.

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Case Utility 310B Backhoe-Loader

282. The Case wheel-mounted backhoe-loader is described and illustrated in 8-page, 3-color Bulletin CUS-110, released from J. I. Case Co., Racine, Wis. Check the reply card for mechanical details of the backhoe, loader and heavy-duty tractor.

Electric Plants, Warning Flasher Lights and Concrete Vibrators

348. Models, specifications, accessories and other data on flasher lights, electric plants and vibrators are covered in catalog from Pacific Mercury, 13232 Leadwell, North Hollywood 9, Calif.

Design Manual on Sectional Plate Pipes, Arches and Pipe-Arches

550. Size and weight tables, minimum gages for live load strutted and unstrutted, layout details and plan developments are some of the material covered in this manual. Write American Bridge Div., United States Steel Corp., 525 William Penn Place, Pittsburgh, Pa., or check the reply card today.

For Soil Sampling and Pavement Coring

576. There's an easier way to do both with Acker equipment. Bulletin 26-R describes a kit containing 12 different soil sampling tools. Bulletin 40-R tells about the All-Purpose auger for all types of sub-surface exploration. Bulletin 700-R illustrates the Acker Shear Test Kit for in-place shear tests in soft areas. Name the ones you want. Acker Drill Company, Inc., Box 830, Scranton, Pa., or check our card.

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264. Truck axles that provide easy shift, supply positive lubrication and have a self-contained air brake are available from Eaton Mfg. Co. For complete information on these rugged axles check the reply card or write Eaton Mfg. Co., Cleveland, Ohio.

Reinforced Concrete Cribbing for Highways and Embankments

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303. Pow-R-Stump cutter is operated by one man, handles stumps of any width and up to 33 ins. in height and will not damage curbs, driveways or sidewalks. For literature check the reply card or write Vermeer Mfg. Co., Pella, Ia.

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342. The Kelley Power Tamper is a self-propelled unit that is equivalent to a 10-ton roller for backfilling, road widening jobs and compacting around culverts and pipeline trenches. For complete specifications write Kelley Machine Div., Wiesner-Rapp Co., Inc., 285 Hinman Ave., Buffalo 23, N. Y., or check the reply card.

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484. Complete up-to-the-minute information on all types of surface treatments is covered in manual available from American Bitumuls & Asphalt Co., 320 Market St., San Francisco 20, Calif. The Manual provides on-job reference as well as engineering department use and it covers every step from pavement inspection to traffic-control on the finished pavement. Check the reply card.

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450. Parking lots, airfield runways, driveways and playground areas are places where Koppers pavement sealer can be used. Check the reply card or write Koppers Co., Inc., Tar Products Div., Pittsburgh 19, Pa., for data on this easy to apply sealer.

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586. Mixers capable of mixing 3 to 30 tons of hot mix per hour are described in literature available from McConnaughay Mixers, Inc., Lafayette, Ind. Check the reply card for full information on patching, repairing, resurfacing and sealing.

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Better Roads With Sterling Rock Salt

650. This manual describes the simplified 7-step method of road improvement with rock salt. This type of salt stabilization is designed for cities, townships and counties. Check the reply card or write Highway Sales Dept., International Salt Co., Clarks Summit, Pa., today.

Sweepers Handle A Variety of Jobs In Every Season

684. Mechanical drive one-way and pull type 2-way sweepers and hydraulic 2-way sweepers that are tractor-mounted or loader-mounted are fully covered in literature from M-B Corp., 1611 Wisconsin Ave., New Holstein, Wisc. Jobs like cleaning dust, dirt and snow from streets and highways and sweeping park lawns are a few of the sweepers applications. Check the reply card.

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639. Specially designed for land-clearing, mulching and right of way maintenance. Exclusive features include shielded fly wheel for delivery of steady power flow, ability of cutter to ride over obstacles without affecting cutter action. For Jeeps or 3-point lift type tractors. Get the full story from W. F. Covington Planter Co., Dothan, Ala. or circle the number on our card.

Design of Concrete Pavements For City Streets

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Manual on Highway Railings For Bridges and Roadways

660. This manual covers design suggestions, components, specifications for design and construction and the advantages of Alcoa aluminum alloy highway railings. Check the reply card or write Aluminum Company of America, Alcoa Bldg., Pittsburgh 19, Pa., for this valuable manual.

RECREATION

How to Equip Your Parks and Playgrounds

414. A handsome 60-page illustrated catalog showing a full line of extra heavy duty playground, park picnic and dressing room equipment, plus many related items, is now available from American Playground Device Co., Anderson, Ind. Complete specifications, construction features, prices and details of labor and materials needed for installation are included. Check the reply card.

REFUSE COLLECTION AND DISPOSAL

Make Molehills out of Your Refuse Mountains

94. New and better ways of refuse and garbage collection and handling are described in newest literature on collection systems employing giant containers, bodies and trailers that speed your work, cut costs, improve sanitation. Adaptable to small cities as well as large. Write Dempster Brothers, Dept. PW, Knoxville 17, Tenn., or circle the number on our card.

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Literature Describes M-B Contain-O-Pack System

190. A 6-page catalog describing the M-B Contain-O-Pack, a complete low cost containerized refuse system for private haulers and municipalities is available from M-B Corp., New Holstein, Wisc. Check the reply card.

General Specifications for Refuse and Garbage Trailers

251. Two bulletins, one on the Pak-Mor 38 cu. yd. tandem axle trailer unit and the other on the Pak-Mor 32 cu. yd. trailer for use with Model GRD Dempster are available from Pak-Mor Manufacturing Co. Box 14147, San Antonio, Texas. General specifications, power train, operating procedures, maintenance and lubrication and other helpful information are included.

Where Does It Go From Here?

63. That is the title of new 12-page booklet, D 930, with thorough discussion of garbage disposal by sanitary landfill method. Read the latest report from the experts. Caterpillar Tractor Co., Peoria, Ill., or check card.

Methods and Benefits of Sanitary Landfill

409. Information on Sanitary landfill methods, organization and necessary equipment with which to carry out the job is available from the Construction Machinery Div., Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Load-Packer 600 Points the Way to the Best in Refuse Collection

188. Bulletin W-200 explains how the Gar Wood Load-Packer gives faster operation, bigger payload, more compaction, a larger hooper and more dependable operation. Write Gar Wood Industries, Inc., Wayne, Mich., or check the reply card for full details.

STREET LIGHTING AND TRAFFIC CONTROL

Westinghouse Silverliners With or Without Built-In Ballast

259. For complete catalog on these mercury luminaires check the reply card or write Westinghouse Electric Corp., Lighting Div., Edgewater Park, Cleveland, O. Full details are covered on these lighting units.

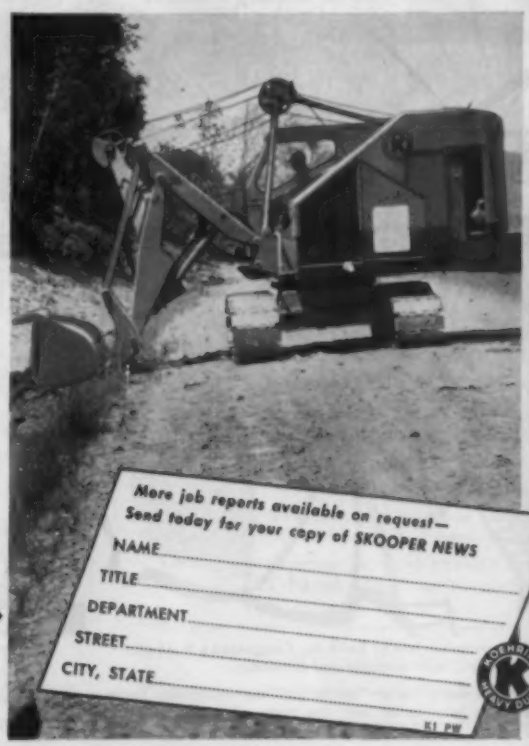
Put Traffic Signals Out Where They Can be Seen

606. A 20-page booklet points out how to do this most effectively, gives fullest detail. Follow it and more motorists will love you. As first step, ask for Catalog TE-1 of Pfaff & Kendall, 84 Foundry St., Newark 5, N. J., or circle number on our card.

. . there's nothing like it — on wheels or tracks!

Take the full-revolving swing of a shovel, add the big bucket capacity and versatility of a tractor loader, and what do you have? *A new concept in speed loading* — with none of the usual drive-in, back-out waste motion of front-end loaders, none of the high tire or track maintenance of skid-turn operation. Skooper swings through continuous dig-swing-dump-return cycles without traveling — crowds 2-yard bucket along 7-foot level clean-up from "stand-still" position. Result: more versatility, more output, at substantial savings in fuel and maintenance costs. That's not all! Standard shovel-hoe-crane attachments make Skooper a doubly-sound investment for your carefully-budgeted dollars. Call Koehring® distributor, or write us for full details.

KOEHRING
DIVISION OF KOEHRING COMPANY
3026 W. Concordia, Milwaukee 16, Wis.



Keeps traffic open during clean-up

KENTUCKY — Highway department's Skooper cleans ditches, trims shoulders, banks, clears rock slides — stays in one lane, keeps other lane open to traffic. Skooper bucket reaches below the grade, above the grade, crowds straight ahead, or cuts at any angle of the bank slope.

To order these helpful booklets check the reply card opposite page 38.

CONSTRUCTION EQUIPMENT AND MATERIALS

Tractor Loader Can Be Converted Into Eight Different Machines

26. Multiple-purpose tractor loader can be converted to a street sweeper, backhoe, fork lift, angle dozer, crane and rotary broom in a short time. Check the reply card or write Massey-Ferguson Industrial Div., 1009 South West St., Wichita 13N, Kans., for well illustrated catalog.

Don't Stand There Figuring!

51. Use the new Forney PSI Calculator "slide rule" for concrete products that includes instant conversion data from total load to psi on 17 standard test specimens and masonry units. Pocket size. Free. Address Forney's Inc., Tester Div., Box 310, New Castle, Pa.

Useful Attachments for "Payloader" Tractor Shovels

98. Increased versatility for Hough "Payloader" tractor shovels is made possible by the various attachments described in literature of the Frank G. Hough Co., 761 Seventh St., Libertyville, Ill. Illustrated and described are rotary "V" and trip-blade snow plows, hydraulic backhoe, back-filler blade, pickup sweeper, scarifier teeth, winches, etc.

How to Get Better Grader Operation

111. A most interesting and instructive 20-page illustrated action booklet on how to operate a motor grader is now available from Galion Iron Works & Mfg. Co., Galion, Ohio. Designed to help operators get more effective use from the versatile motor grader, this booklet covers the hydraulic system, steering, tips on leaning wheels, proper blade positioning, turning, gear speeds and operating procedures. Colorful, easy-to-read presentation guarantees good readership. Check the reply card for your copy.

400 Tons an Hour With Only 64 Hp . . .

100. That's just one report on the Koehring "Skooper" which is combining the full-revolving swing of a shovel with the big bucket capacity and versatility of a tractor loader, giving a new concept in speed loading. Cuts costs at every turn. Address Koehring Div., 3026 W. Concordia, Milwaukee 16, Wis. or circle the number on card.

Booklet Shows Design of Pre-Engineered Steel Buildings

271. Pre-engineered Butler steel buildings are available in every size, type and design to meet your buildings needs. In a helpful 12 page four color booklet you will find details on several basic designs for community use; answers to your questions on construction and erection; and many illustrations of typical uses. Write to Butler Mfg. Co., Kansas City, Mo.

Hydra-Drives Power Shift Transmissions

283. With four speeds forward and reverse, the Hydra-Drives is ideally suited for vehicles which must travel in both directions during a normal work cycle. Check the reply card or write Rockwell-Standard Corp., Transmission and Axle Div., Detroit 32, Mich., for full details.

Complete Line of Shovels, Draglines, Cranes and Clamshells

361. Bucyrus-Erie crane-excavators in sizes from ¾ to 4 cu. yd. capacities are covered in literature from Bucyrus-Erie Co., South Milwaukee, Wis.

Complete Bulletin On Municipal Supplies

473. Everything from leak locators to street signs is listed in the big 100 page bulletin "Municipal Supplies" published by Darley. Hundreds of different items for all city departments are included. Get your copy of Bulletin No. 135 from W. S. Darley & Co., 2814 Washington Blvd., Chicago 12, Ill.

Tractors and Equipment for Municipal Use

407. Specification sheets for the John Deere crawler and utility wheel tractors; also equipment for loading, dozing, mowing, sweeping and many other operations. John Deere, Industrial Division, Moline, Ill. Check the reply card. State type of tractor and equipment.

The Trucks You Need for Every Public Works Job

461. Extra life and operating economies are built-in features of every Ford truck model. There's a chassis size and engine for each of your needs, from light utility work to heavy-duty construction jobs. Get latest literature from Ford Motor Co., Truck Div., Dearborn, Mich., by checking the reply card.

1960 Truck Line Story From Chevrolet

446. The 1960 Chevrolet truck line is described fully in literature from Chevrolet Motor Division, General Motors Corp., General Motors Building, Detroit 2, Michigan. Check the reply card for data on this line of 165 models.

Data on Portable and Stationary Air Compressors and Accessories

482. Covered in literature available from Gordon Smith & Co., Inc., Bowling Green, Ky., are the basic designs of portable air compressors, models, operating features and specifications. Check the reply card.

Construction Guide For Engineers and Builders

649. A 34-page four sectioned construction guide containing full-page structural drawings that provide basic information on types, grades and applications of fir plywood for engineers and builders has been released by Douglas Fir Plywood Association, Tacoma 2, Wash. Check the reply card for data on floor construction, single and double wall construction and roof construction.

"Hardrock Smitty" says:— **IT TAKES A SMITH 125 AIR COMPRESSOR TO DELIVER ON THE TOUGH JOBS . . .**

Built to "take it" when the going get tough, the Smith 125 Air Compressor will give you years of low cost, dependable service. The Rugged Hercules Industrial engine delivers over 125 c.f.m. hour after hour, day in and day out.

LOOK AT THESE FEATURES:

- low initial cost
- low operating cost
- easy maintenance
- simple, compact design
- 12 volt electrical system
- 125 c.f.m. at 1165 rpm
- operates two 85 lb. paving breakers at same time

Compare price . . . compare job results—you'll "Go Smith" with "Hardrock Smitty"!

There's also a complete line of Smith Air Compressors in 45 cfm and 75 cfm models, both portable and stationary.

Ask your dealer for an "on the job" demonstration. (write us for complete information and the name of your nearest dealer.)

SMITH AIR COMPRESSORS

GORDON SMITH & COMPANY, INC., Bowling Green, Ky.

REPORTS *on concrete bonding with adhesives based on THIOKOL Liquid Polymer*

#4 FASTENING TRAFFIC BUTTONS AND CURB MARKERS... *for good and without mechanical means*

The California State Highway Department discovered it . . . adhesives based on THIOKOL polysulfide liquid polymer produces a concrete-to-concrete bond *that's stronger than concrete itself.*

In an experimental application, traffic buttons were fastened to pavement using the adhesive alone—substituting for the conventional, time-consuming and troublesome method of steel doweling. The experiment took place at a highway point averaging 30,000 vehicles a day. Although the installation was made six years ago, the buttons are still completely intact and in service. The test was repeated in areas where traffic is still greater. Of the thousands upon thousands upon thousands of buttons installed this quick, easy way, failures of less than 1/10th per cent have been noted.

The same THIOKOL LP-based concrete adhesive has since successfully met the challenges of time, temperature and wear on other highway applications—in repairing spalled and scaled areas, broken slabs and cracks, in securing cement overlays, in skidproofing and sealing. To get the full story, mail the coupon.

Thiokol®

CHEMICAL CORPORATION

780 NORTH CLINTON AVENUE • TRENTON 7, NEW JERSEY

In Canada: Naugatuck Chemicals Division, Dominion Rubber Co., Elmira, Ontario

®Registered trademark of the Thiokol Chemical Corporation for its liquid polymers, rocket propellants, plasticizers and other chemical products.

FOR MORE INFORMATION: Mail coupon to Dept. 53, Thiokol Chemical Corp., 780 N. Clinton Ave., Trenton, N. J.

Gentlemen: Please send me available data on THIOKOL LP-based adhesives for highway use.

Firm_____

Street_____

City_____ State_____

Your Name_____

"We carry up to 2,500 lb. more FORD Tandems and still outrun

SAYS HARRY R. KUNZ
PRESIDENT, KUNZ PAVING CO.
SAN MATEO, CALIFORNIA

Mr. Harry R. Kunz, a Registered Public Accountant in the construction field for 20 years, started the Kunz Paving Company in 1954. He and his two sons, Harry Jr. and Gerald, expect to do $500,000 worth of work with their fleet of 16 Ford Trucks this year. Here is what he has to say about these trucks.

"Our experience with Fords has proved them to be the best all-around truck we can buy! They haul more payload, cut down considerably on trip time and cost less to operate and maintain.

"The lighter chassis weight of the Ford Tandems lets us carry as much as 2,500 pounds more than competitive makes. This extra payload means that we can haul as much in ten trips as the others do in eleven. Our Fords will beat them on a trip-for-trip basis, too!

"On a 30-mile haul, our '59 T-800 equipped with Transmatic Drive will lap other trucks on the same job every fourth trip. This not only reduces our hauling costs but it makes our Ford's more attractive as rental units for other contractors. One of our associates had two of his trucks and two of our Fords working on the same job. He actually paid for the rental of our trucks by the extra trips they made.

"Our cost records, set up on an hourly basis to make it easier to prepare bids, show that the longer life built into Ford Trucks makes them less costly to operate. We have one '56 Ford T-750 with over 100,000 miles on it that we use as a base for our tandem hauling costs. In spite of its high mileage – gas, oil, tires, maintenance and repairs amount to only $2.08 per hour. Facts and figures like these keep us sold on Ford Trucks for our business."

payload on our other trucks on the same job!"

Again in '60... FORD PICKUPS beat all leading makes in Gasoline Economy!

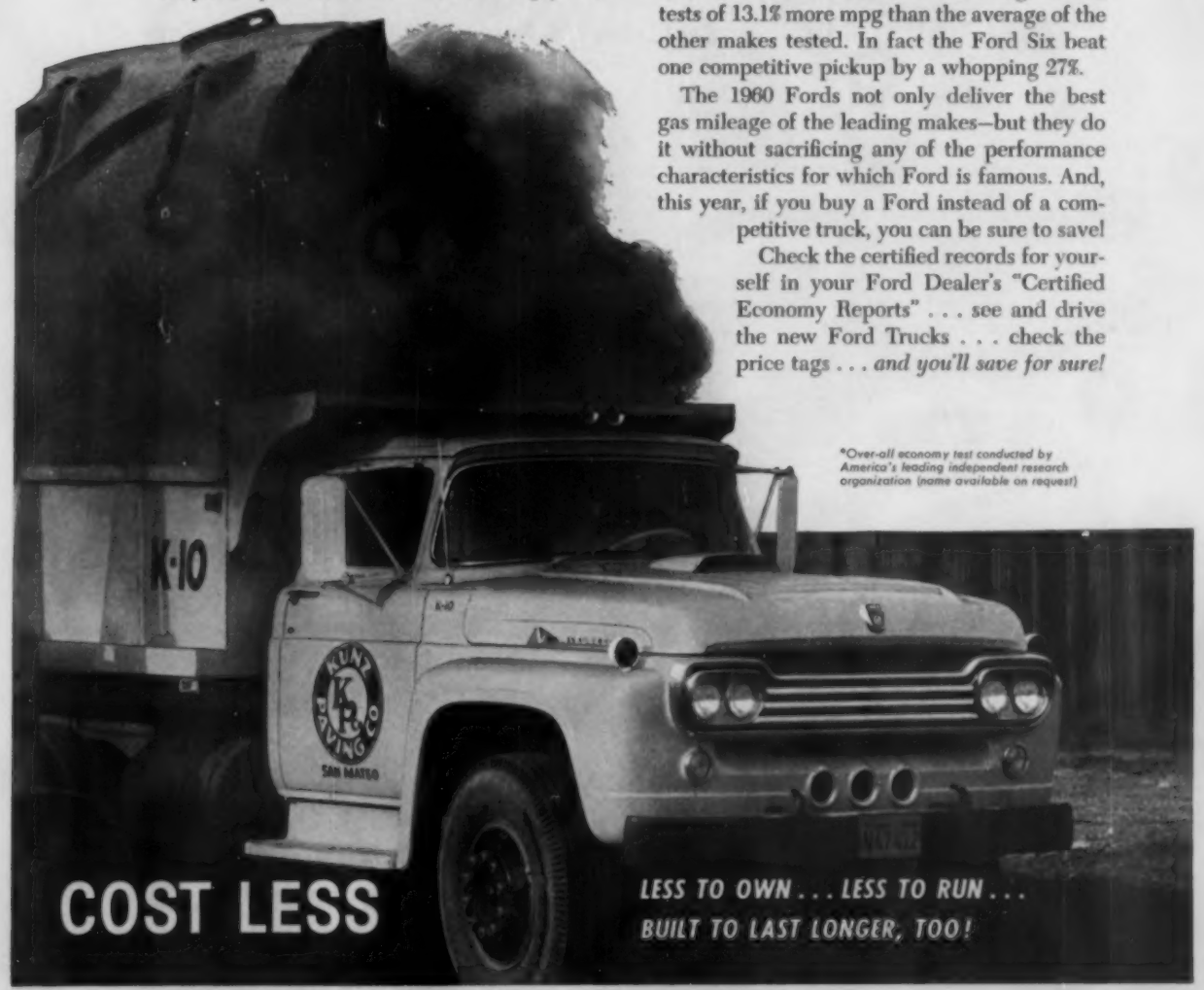
Ford Six delivers 13.1% better gas mileage in second running of Economy Showdown U.S.A.* Standard 1960 ½-ton pickups of the five leading makes were purchased from dealers just as you would and run both empty and loaded, over flat terrain and hills, at low and high speeds, under city traffic and retail delivery conditions.

Certified results show the Ford Six won *every* test—with a combined Ford advantage for all tests of 13.1% more mpg than the average of the other makes tested. In fact the Ford Six beat one competitive pickup by a whopping 27%.

The 1960 Fords not only deliver the best gas mileage of the leading makes—but they do it without sacrificing any of the performance characteristics for which Ford is famous. And, this year, if you buy a Ford instead of a competitive truck, you can be sure to save!

Check the certified records for yourself in your Ford Dealer's "Certified Economy Reports" . . . see and drive the new Ford Trucks . . . check the price tags . . . *and you'll save for sure!*

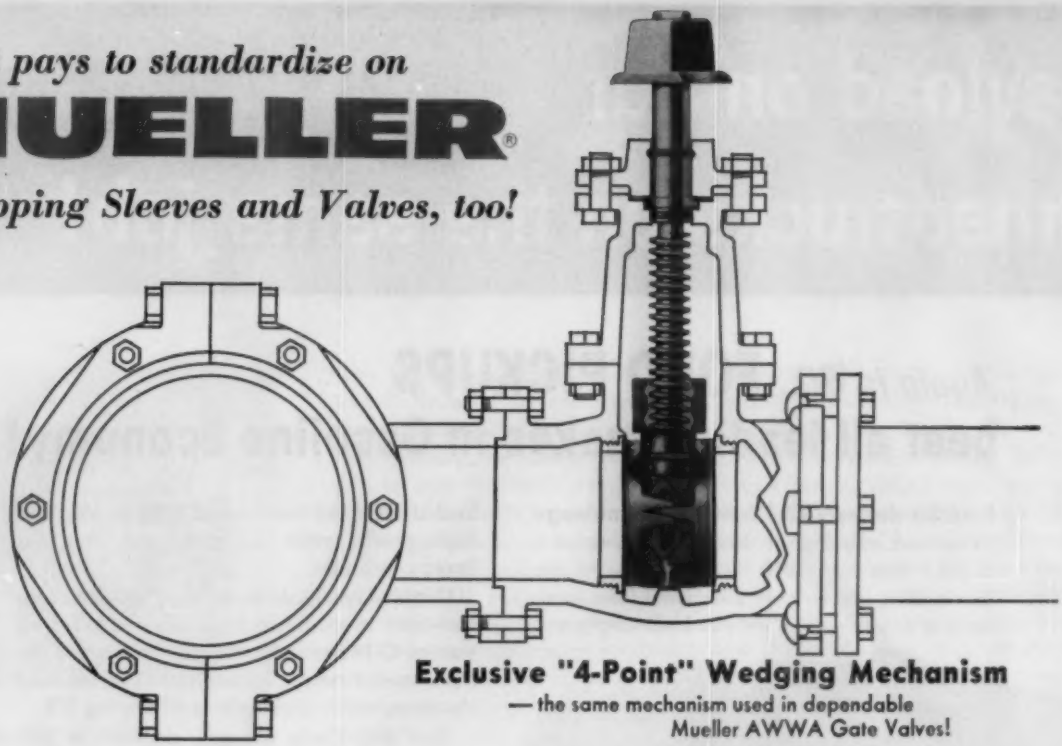
*Over-all economy test conducted by America's leading independent research organization (name available on request)



it pays to standardize on

MUELLER®

Tapping Sleeves and Valves, too!



Exclusive "4-Point" Wedging Mechanism
— the same mechanism used in dependable Mueller AWWA Gate Valves!

Save time and money by specifying "quality-matched" Mueller Tapping Sleeves and Valves throughout your system.

Laterals and branch main connections may be made quickly and easily with unskilled labor under full line pressure and with no loss of water.

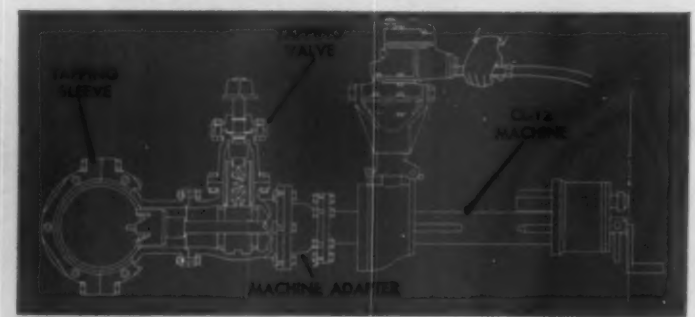
The extra long length and heavy cross sections of all Mueller Tapping Sleeves actually strengthens the main at the lateral connection. Mechanical joints or calked joints permit rapid pressure-tight installations. Just two sets of end gaskets readily adapt a nominal size of mechanical joint sleeve to all classes of cast iron pipe regularly used.

Smaller inventories, gained storage space and easier maintenance are yours if you've also standardized on job-proven Mueller Gate Valves. The wedging mechanism of non-rising-stem Mueller Tapping Valves is identical to that of Mueller AWWA Gate Valves. In fact, the parts are completely interchangeable! "O" ring stem seals or conventional packing are also available.

Mechanical joint and calked type sleeves and valves are available in a full range of main and branch main sizes.

Write for complete information and specifications on Mueller's full line of Tapping Sleeves and Valves.

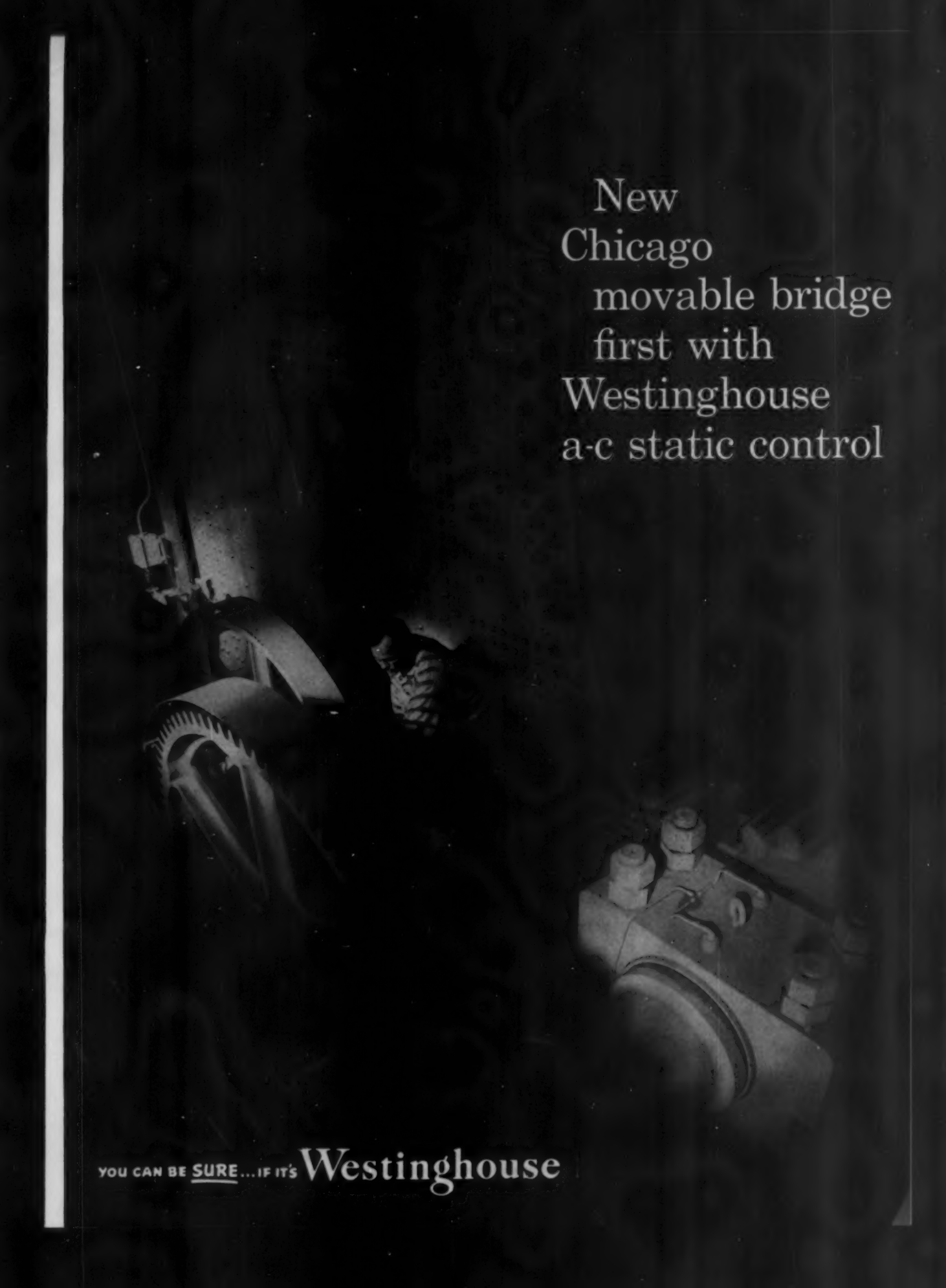
Use the Mueller CL-12 Drilling Machine to install Tapping Sleeves and Valves faster than ever before.



These are just a few of the bonus features found in all "quality-matched" Mueller products for water distribution systems. Add up these features and you'll see why so many cities and towns have "standardized on Mueller."

MUELLER CO.
DECATUR, ILL.

Factories at: Decatur, Chattanooga, Los Angeles, In Canada: Mueller, Limited; Sarnia, Ontario


New
Chicago
movable bridge
first with
Westinghouse
a-c static control
YOU CAN BE SURE ... IF IT'S Westinghouse

COVER PHOTO: View at West Van Buren Street Bridge, Chicago, showing leaf rack, pinion and main drive gearing operated by Westinghouse Bridg-O-Matic control to raise and lower east leaf of bridge.

Double leaf, trunnion bascule bridge opening for Chicago River traffic. One man in operator's room, East Pier, upper right, controls the bridge by means of an all a-c system employing Westinghouse saturable reactor-type controller.

J-94132-2

W. C. Carl, Construction Engineer, Westinghouse (standing), discusses Bridg-O-Matic drive with Stephen J. Michuda, Chief Bridge Engineer, City of Chicago, at right, and his staff (left to right): S. Frayer, Structural Engineer; M. D. Krausman, Assistant Chief Bridge Engineer; and R. H. Keil, Electrical Engineer, Bridge Division.

Stephen J. Michuda; M. B. Trimble, Construction Sales Engineer, Westinghouse; and William G. Divane, President, Divane Brothers Electric Company, Electrical Contractors, discuss main control desk which centralizes operation of leaf and auxiliary drives and selection of east and west incoming service feeders. Instruments on sloped panel indicate leaf position and electrical circuit conditions.

View of switchboard room showing incoming line switching equipment, magnetic control for auxiliary drives, Bridg-O-Matic wound rotor motor control panels and saturable reactor cubicles. Robert E. O'Brien, Chief Electrician, examines panel containing emergency control switching equipment at far end of room.

Westinghouse Bridg-O-Matic Control specified to operate Chicago's West Van Buren Street Bridge

An important factor in the design of the West Van Buren Street movable bridge in Chicago was the selection of the most efficient drive and control system available. Westinghouse Bridg-O-Matic* control was specified after a study of its advantages over other types of control.

The West Van Buren Street Bridge is a double leaf, trunnion bascule bridge across the south branch of the Chicago River and is designed to carry vehicular and pedestrian loads. Each bridge leaf is normally operated by two 100-hp a-c wound rotor induction motors. For emergency operation, a single motor per leaf may be used. During normal operation, the time required to open or close the bridge is approximately 55 seconds. Four electrically operated thrustor brakes are provided for holding each leaf in the desired position. Minimum brake shoe lining wear is encountered since the leaves are normally retarded by the motors through the action of the static reactor/Magamp controller to a low speed before the brakes are caused to set.

The normal control of the two operating motors for each leaf, connected for parallel operation, is by means of the Bridg-O-Matic control (a-c reactor control system). The speed torque performance of this system provides precision operation under all conditions of leaf load from normal to a 10-lb wind, without the use of any "mechanical" braking, for positive slowdown and reduced speed operation.

Electric power, supplied by two independent networks, is three phase, four wire, 60 cycle at 208/120 volts, stepped up at the bridge through transformers to 480 volts.

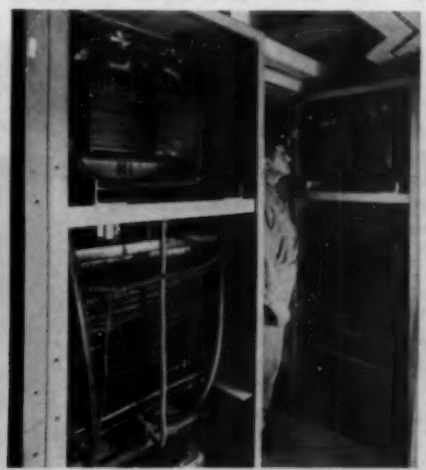
An alternate control system may be selected by moving the control selector switch from "Reactor" to "Off." This provides the conventional reversing wound rotor controller with six power points and a drift point. Either motor may be used. (*contd.*)

*Trade-Mark

J-94132-3

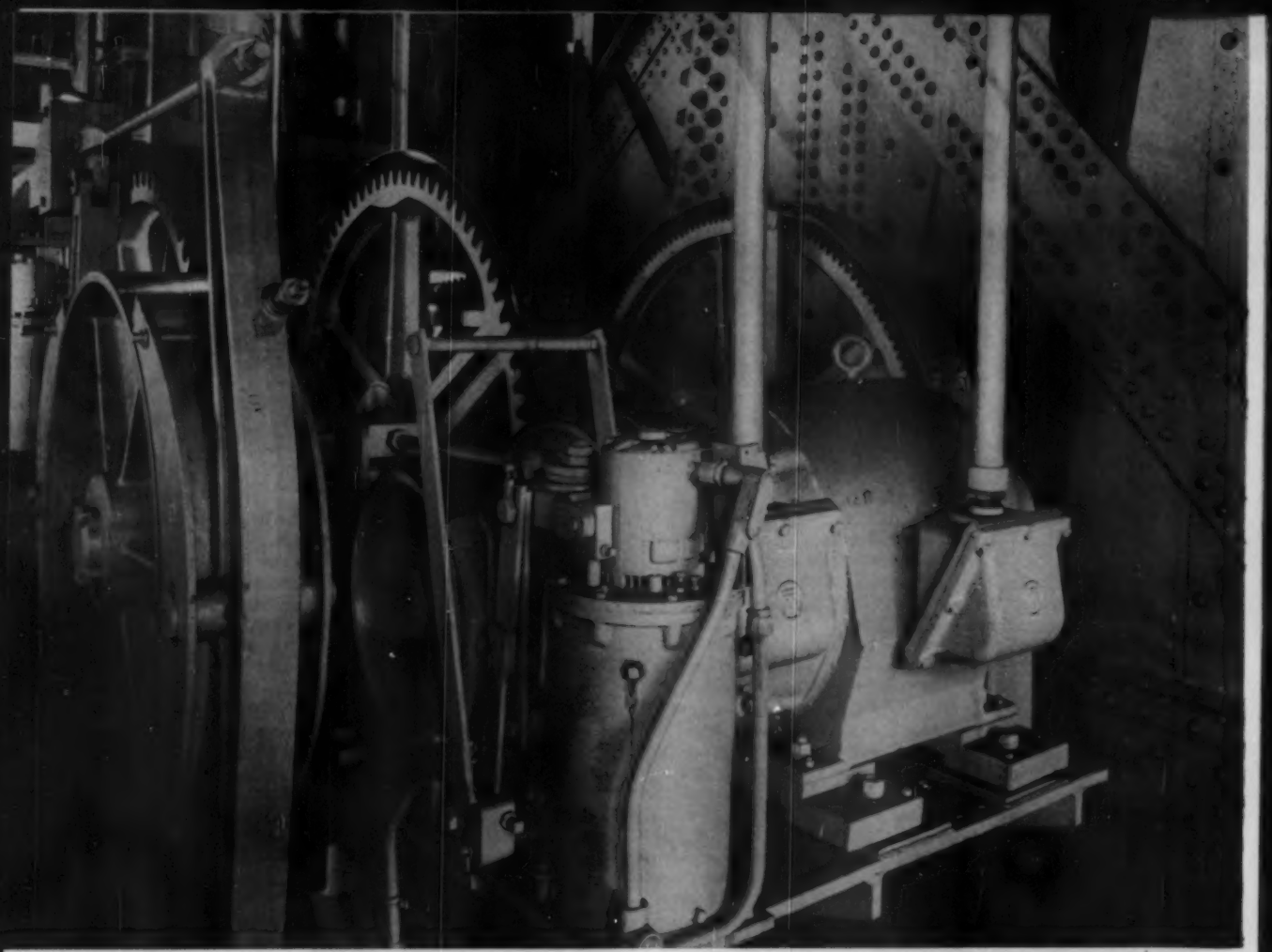
YOU CAN BE SURE...IF IT'S
Westinghouse

L. A. Johnson, Westinghouse Sales Engineer; E. A. Leske, Electrical Engineer, Divane Brothers Electric Company; and R. H. Keil inspect Westinghouse Magamp control section of bridge switchboard.



Chief Electrician, Robert E. O'Brien, checks cubicles which house Westinghouse primary saturable reactors.

Incoming line cubicle of bridge control (switchboard room, East Pier) is inspected by W. C. Carl; Edward Klausner, Engineer in Charge of Bridge Construction; and R. H. Keil.



View showing one of leaf drives (there are two per leaf), each with Westinghouse 100-hp a-c wound rotor motor and a-c thrustor-operated motor and machinery brakes.

Westinghouse Bridg-O-Matic operates Van Buren Street Bridge (contd.)

Interlocks are provided in the control system to prevent operation of leaves until all flashers, traffic lights, gongs and warning horns are operating, traffic gates are down, and bridge centerlocks are withdrawn.

Westinghouse saturable reactor a-c systems offer many possibilities for vertical lift, bascule or swing bridge designs, and other applications such as dam and lock gates, cranes, hoists, etc. For more information call your Westinghouse electrical construction engineer, or write: Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pa. J-94132-4

OWNER & DESIGNER: City of Chicago, Ill.
Department of Public Works, Bureau of Engineering
Division of Bridges and Viaducts

CONSULTING ENGINEER: Hazelet & Erdal, Louisville, Ky., and Chicago, Ill.

ELECTRICAL CONTRACTOR: Divane Brothers Electric Company, Chicago, Ill.

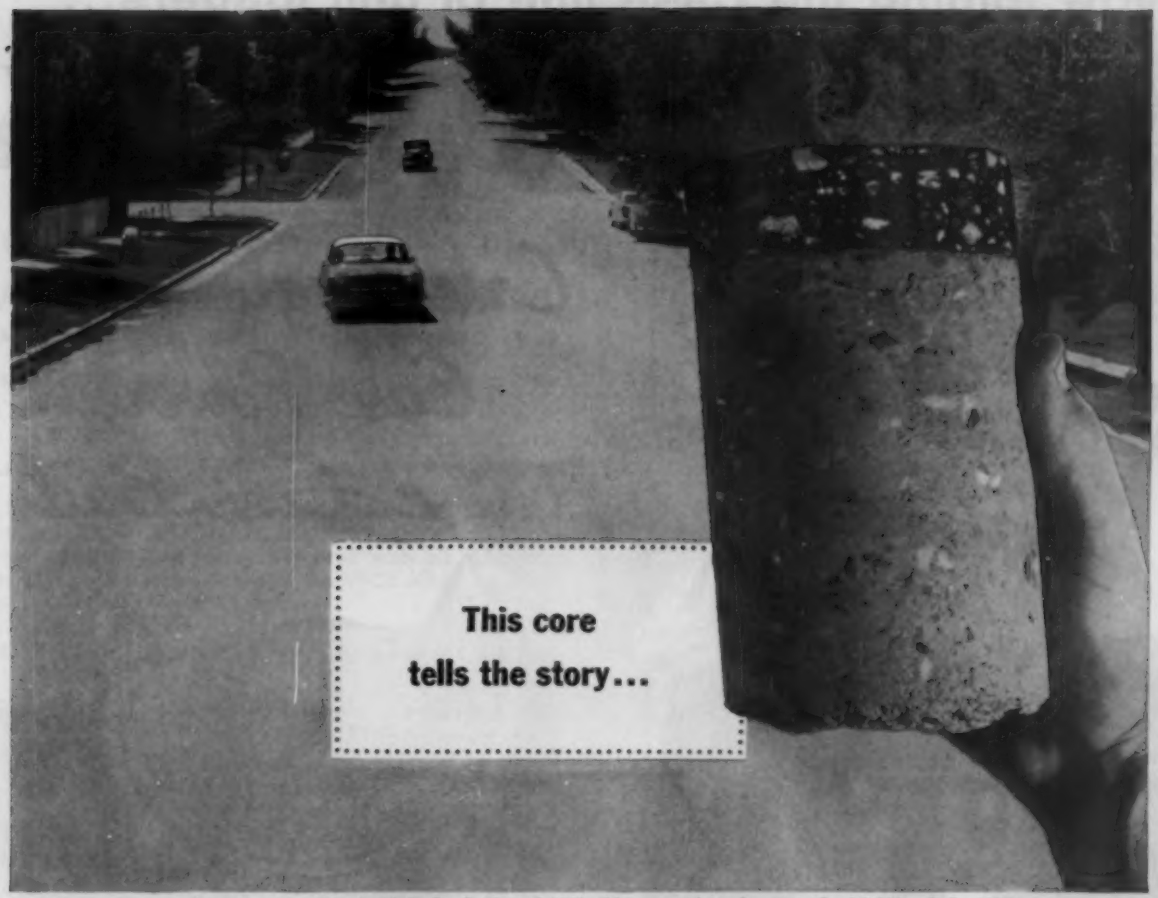
SUPERSTRUCTURE-MACHINERY CONTRACTOR:
Overland Construction Company, Chicago, Ill.

STEEL FABRICATOR: American Bridge Division, United States Steel Corporation, Pittsburgh, Pa.

YOU CAN BE SURE...IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV ALTERNATE FRIDAYS

John A. Machiels, Bridge Maintenance Machinist, looks at the 225-kva Westinghouse Inerteen®-filled step-up transformer which provides 480-volt supply for bridge drive motors and auxiliaries. Type DB-50 wall-mounted circuit breaker provides main feeder protection.



Strength more than doubled! *In October of 1959, this core registered a strength of 2,200 psi. In 1952 samples from these streets had a 7-day strength of 936 psi. Ten per cent portland cement was used.*

In just 7 years, strength of soil-cement streets in Gillette, Wyoming, increased 135%

...soil-cement pavement grows stronger year by year!

Core test proves conclusively: soil-cement outlasts any other low-cost paving material! Soil-cement is stronger inch for inch than any other paving material, short of concrete. Yet, in most cases, 75% of the materials are free.

Your main ingredient is soil... even old gravel bases or broken-up blacktop can be mixed in. This is combined with portland cement and water, then covered with a thin bituminous wearing surface when the soil-cement hardens. Contractors have built as much as two miles of soil-cement pavement in one day.

Potholes or soft spots are a thing of the past. Soil-cement has beam strength that spreads the traffic load over the subgrade. Maintenance is really low. Coupled with a low first cost, it means street budgets go further... permitting long range programing by engineers.

More than 500 cities and towns throughout the country have successfully used soil-cement paving.

PORTLAND CEMENT ASSOCIATION

A national organization to improve and extend the uses of portland cement and concrete

MODERN
soil-cement

Now joining the Case line of unit loaders...

NEW 9000-lb., 2½

Case Engineered...
Case Powered...
Case Built

Equipped with constant-mesh power-shift transmission, power-boosting torque converter, power-transfer differential and effortless rear-wheel power-steering. Optional: 1⅛ cu. yd. heavy-duty bucket with digging teeth, 3½ cu. yd. light material bucket.

23,500 lbs. breakout... 40° bucket rollback

Big 16.00 x 24, 12 ply tires... speeds to 23 mph

cu. yd. CASE® W-12

Designed to achieve the ideal power-torque-weight ratio for unprecedented work capacity... unequalled operating economy.

Powered by the big, heavy-duty 120 gross hp Case diesel engine — proved in millions of hours of operation all over the world — the new four-wheel drive Case W-12 loader is ruggedly-built to withstand the toughest kind of digging and materials handling. Compared with all other unit loaders in its capacity range, the W-12 offers you these important advantages:

1. *Up to 30% faster hoisting and lowering time* ... cuts cycle time almost one-third.
2. *Up to 70% greater forward-reach* ... saves time ... lets operator dump load into center of truck without ramming.
3. *Far better balance and stability* ... wide 77¾" tread, plus 26% more empty-weight on rear wheels, gives greater stability, better traction for digging ... enables operator to raise full bucket on-the-go without tipping.
4. *Easier, safer to operate* ... forward mounting of loader arms lessens the danger of catching operator's arm in lifting mechanism.
5. *Up to 19% saving in initial cost* ... means more output per dollar of investment, lower cost per yard or ton of material handled.

For convincing proof, ask your Case Industrial Dealer for a free demonstration, or mail handy coupon for full details.

CASE.

J. I. CASE COMPANY, RACINE, WIS.

9 ft. dump clearance ... 17 inch ground clearance

Sizes to fit every job

W-5

3000-lb. capacity—1 to 1½ cu. yd. buckets

W-9

5500-lb. capacity—1¼ to 2¼ cu. yd. buckets

W-10

6500-lb. capacity—1¼ to 2¼ cu. yd. buckets

CLIP ... MAIL TODAY

J. I. CASE CO., Dept. C1340, Racine, Wis.

Please send full descriptive literature on:

☐ 9000 lb. W-12 ☐ 6500 lb. W-10 ☐ 5500 lb. W-9 ☐ 3000 lb. W-5

☐ Have nearest dealer call to arrange demonstration.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

C-TL-442

Repair street damages caused by Winter freezes NOW!

MODEL PM-430
PATCHMOBILE
PORTABLE
HOT ASPHALT PLANT

The only all-in-one self-contained asphalt maintenance machine with rotary dryer, pugmill driven through enclosed gearbox, 250 gallon asphalt tank, automatic asphalt metering system and low-pressure burners. You can start SPRING patching earlier, and make better street repairs all through the year with this COMPLETE plant at no extra cost.
Write for complete information.

Wylie

WYLIE MANUFACTURING CO., INC.
P. O. BOX 7086 • OKLAHOMA CITY 12, OKLA.

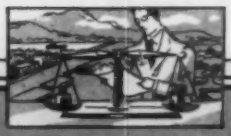
Turn Your Meter Reading inside-OUT!
with ViSi METER

ViSi-Meter
Accurate within .01%
Requires minimum up-keep
Protected with Tamper proof seals

Remote registry for
WATER OR GAS METERS
AT LAST a practical remote indicator and recording system. Tested and approved. Now used by 53 cities. ViSi-Meter eliminates city expense and liability of controlling keys to customers' residences. Easily read in one trip by meter readers.

Customers like ViSi-Meter because no one need enter the home to read the meter.

THIS PRODUCT IS MANUFACTURED AND GUARANTEED BY
ViSi-METER, Inc.
301 NORTH 17th STREET KANSAS CITY, KANSAS



LEGAL ASPECTS OF PUBLIC WORKS

MELVIN NORD, Dr. Eng. Sci., LL.B.

Defects in Streets

Becker v. City of Milwaukee, 99 N.W. (2d) 804, a Wisconsin case decided Dec. 1, 1959, was a bus driver's action against the city and a private contractor for injuries which he sustained when the front wheels of the bus which he was driving suddenly dropped into a hole or depression. The depression was at the site of a trench which had been excavated across the roadway and which resulted from the settling of fill which had been placed in the excavation by the contractor.

The trial court found that both the defendants were negligent in failing to repair the trench properly, but that the plaintiff was equally negligent with respect to speed, management and control of the bus, and lookout. The plaintiff was therefore denied any recovery by the trial court.

The negligence of the plaintiff was based on the fact that the depression had been there for 2 weeks and that bus drivers were very careful in crossing it, crawling at 2 to 3 miles per hour. Despite the fact that lighted barricades had been placed at each end that evening, after a bus had become stuck in the depression, the plaintiff drove onto the depression at 10 to 15 miles per hour.

The Supreme Court of Wisconsin affirmed the judgment of the trial court denying the plaintiff any recovery.

Culverts

Stockstad v. Town of Rutland, 99 N.W. (2d) 813, a Wisconsin case decided Dec. 1, 1959, was an action against the town for property damages and personal injuries resulting from the town's alleged failure to provide a proper culvert.

In 1946 the Town Board improved a town road abutting the plaintiff's premises. In doing so, they raised the grade and removed a culvert, thereby closing a pre-existing water-way and converting the course of the waterway over the plaintiff's premises. This caused a certain deep well on his property to become contaminated by the periodic flooding which followed. As a result of drinking water from this well, the plaintiff's family became ill with trench mouth, mouth sores and dysentery, intermittently from 1946 to the present.

Plaintiff claimed this was a continuing nuisance caused by the town in failing to provide a proper culvert as required by law in the case of roads constructed or improved by the town.

A municipal corporation is not permitted to create a nuisance; and the court therefore held that the plaintiff had stated a proper cause of action (if proven) against the town.

Notice Provisions in Municipal Ordinances

Marks v. City of Battle Creek, 99 N.W. (2d) 587, a Michigan case decided Nov. 25, 1959, involved an action against the city for injuries allegedly caused by the negligence of the city in carrying out a proprietary activity.

A city ordinance required that written notice of any tort claim be served on the city commission within 60 days after the injury. The plaintiff did not satisfy this requirement.

The Supreme Court of Michigan held, however, that this ordinance could not be applied to the case of proprietary activities of the city. Actions arising out of such activities are based on the common law, rather than on statute, and therefore the ordinary statute of limitations (3 years in this case) applies. The notice provision would apparently apply only where the

Covington, Ga. Containerizes Refuse; Cleans Up Downtown Business District

New System Reduces Costs; Draws "Rave Notices" From Users

Covington, Ga.: This progressive city of 8,000, some 30 miles southeast of Atlanta, has installed one of the most complete containerization systems in the country.

Widely known as the "City of Beautiful Homes," Covington had been plagued for some time with inadequate refuse storage facilities. Boxes, bins and knocked-over cans were permitting refuse to scatter and blow over the streets. In some areas, serious fire hazards existed; in others, unsanitary open storage, that attracted rats and flies, constituted a health hazard.

Mayor Nat S. Turner and Sanitation Committee Chairman Don Wood, of Covington, Ga., inspect one of the new refuse containers installed by the City. Forty of these containers, ranging from six to twelve cubic yards, were recently put in service.

Survey Needed

Mayor Nat S. Turner, Sanitation Committee Chairman Don Wood, Finance Committee Chairman Buck Calloway and Sanitation Superintendent O. N. Parnell met and decided to have a fact-finding survey made of the city's refuse disposal system.

Scott Holman, a sanitation engineer with Atlantic Engineering Co. of Atlanta, was chosen to make the survey. He visited every point of refuse accumulation in the commercial district to gather facts and figures. Afterwards, he computed the cubic yardage generated daily at each point, the truck and manpower costs required to move the refuse to the disposal area, and the other cost factors. Holman presented his findings to the Covington City Council, which unanimously approved his recommendation for installation of the DEMPSTER-DUMPSTER System. His survey revealed that all commercial, industrial, public building and school refuse could be handled by a one-man DEMPSTER-DUMPSTER and 40 containers, at an annual savings of over $5,500.

The System was installed in July and was enthusiastically received by all users. Many of the containers were spotted at the curb on Covington's wide sidewalks; others were placed in alleys and behind super markets.

After six months of operation, the initial enthusiasm of the downtown merchants and other users is still undimmed. Due to the many nice comments received, Mayor Turner feels that "the installation of the new system is one of the most important steps forward in the history of Covington."

Survey Offered

Cities interested in receiving a scientific survey of their refuse collection costs are invited to write the manufacturer. There is no cost or obligation for this service. A free brochure describing the DEMPSTER - DUMPSTER System is also available.

DEMPSTER DUMPSTER® SYSTEMS

DEMPSTER BROTHERS Inc.

Knoxville 17, Tenn. Dept. PW-3

Dempster-Dumpster driver attaches lifting chains to loaded container which serves four business houses.

Returning to the cab, the driver hoists container into carrying position for the trip to the disposal area.

Without leaving cab, driver automatically empties a twelve cubic yard container.

HIGHWAY WEED PROBLEMS LIKE THESE

CAN BE ELIMINATED

LIKE THIS WITH AMIZOL WEED KILLER

and Amizol combinations

Using Amizol alone, or in combination with other weed killers, state and local highway departments are instituting successful and complete vegetation control programs along thousands of miles of roadsides, guard rails, gravel shoulders, bridge abutments, center strips and embankments.

Amizol combinations provide longer control of more broadleaf weeds and grasses than any product used alone. They produce rapid knockdown of existing vegetation, better kill of deep rooted perennials and keep the treated area free of weeds all season long.

Costs for total vegetation control are considerably less with Amizol combinations . . . by 30 percent or more. You use less chemical to kill more weeds. Your "spraying season" is longer, just as long as weeds are green and actively growing.

For information on how to begin a practical highway weed control program, write for free booklet describing uses, application data and chemical formulations of Amizol—produced by Amchem Products, Inc., originators of 2,4-D and other basic weed killers.

AMCHEM AMIZOL

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AMCHEM PRODUCTS, INC. (Formerly American Chemical Paint Co.)
AMBLER, PA. • St. Joseph, Mo. • Niles, Calif.

cause of action is statutory, as in the case of street defects.

The court said: "If municipal corporations choose to enter into competition with private persons and corporations in the rugged world of business, we think they should be prepared to take the bitter with the sweet."

Frozen Sidewalk

Laffey v. City of Milwaukee, 99 N.W. (2d) 743, a Wisconsin case decided Dec. 1, 1959, was a pedestrian's action against the city for injuries which he sustained when he fell on a sidewalk which had become slippery because water which had been discharged on it by firemen in performing a flushing operation had frozen.

The city took the position that because its fire department was involved it enjoyed governmental immunity from negligence.

The court held, however, that the city has a duty to keep the sidewalks in repair. Thus, the question was not whether the fire department was negligent in spilling water on the sidewalk, but whether the city was negligent in allowing the water to remain on the sidewalk for the period of time necessary for it to freeze. This is a question of fact for a jury, so the city's motion for summary judgment in its favor was denied.

• • •

Pennsylvania Grants for Sewage Treatment

State grants-in-aid totaling $1,611,659 have been approved by the Sanitary Water Board for 156 municipalities and municipal authorities. The grants, for the year 1958, represent 1.25 percent of $128,884,768, the cost of sewage treatment plant construction for these municipalities.

Actual percentages paid each year vary, depending on legislative appropriations and amounts of eligible costs. The grants are awarded yearly under Act 339 which makes municipalities and authorities eligible for annual payments up to two per cent of sewage plant costs.

St. Lawrence Seaway Film Strip

A film strip on the St. Lawrence Seaway and Power project is now available. There are 41 black and white frames for 35 mm projectors; and a 4-page pictorial discussion guide is included. The price is $3.50. Information from Current Affairs Films, 527 Madison Ave., New York 22, N. Y.

Ageless Concrete Pipe Installed Next to Ageless Arsenal Foundation For Pittsburgh Water Distribution

The building on the right is located at 40th and Foster Streets in the City of Pittsburgh and is part of the old Allegheny Arsenal built in 1814. Dig down alongside its foundation and you'll find it as good today as the day it was laid, unaffected by moisture or the elements of the soil. This foundation is built of a material that is ageless when buried underground—stone.

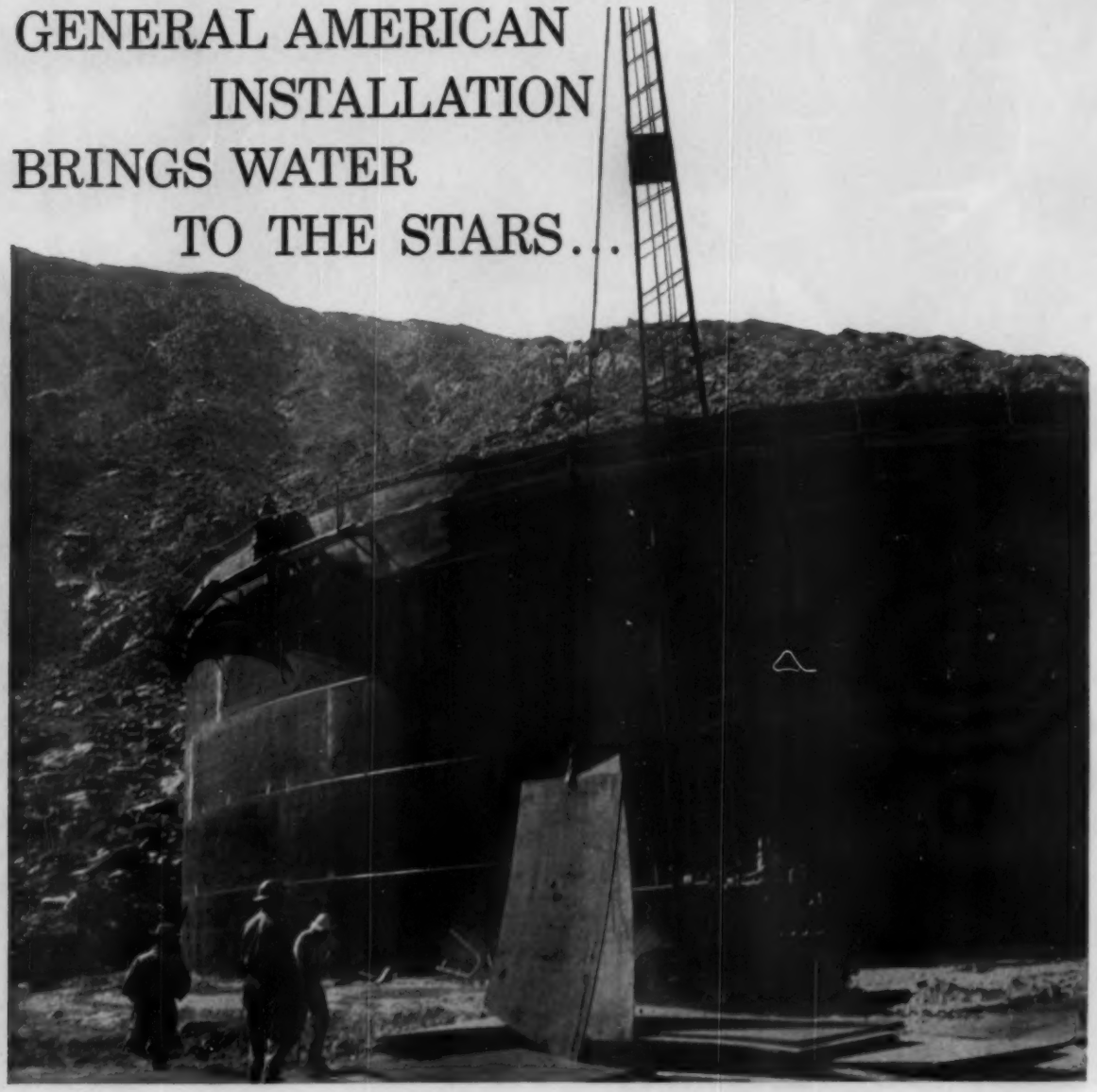
The pipe line being installed is made of another material unaffected by the soil—concrete. The longer concrete is buried underground, the harder and stronger it gets and the more it assumes the characteristics of the limestone from which it comes.

This pipe line will serve the City of Pittsburgh for a long, long time.

Prestressed concrete steel cylinder pipe was used for the 42-inch, 1680-foot-long line which was installed under the direction of John A. Murphy, Director, Morris L. Wolf, Chief Engineer, and John W. Bilotta, Distribution Division, Department of Water, City of Pittsburgh. Frank Kukurin & Sons, Inc., East McKeesport, Pa., was the contractor. The pipe was manufactured by Price Brothers Company, with headquarters plants at Hattiesburg, Miss. for the South and Dayton, Ohio for the North.

Price Brothers
CONCRETE PRESSURE PIPE

GENERAL AMERICAN INSTALLATION BRINGS WATER TO THE STARS...



Palm Springs is a thirsty city. In this desert playground of movie stars and sun-worshippers at the foot of water-rich Mt. San Jacinto are more gardens and swimming pools per capita than any other place in the world. Within the mountain are many underground streams. The problem was to tap the resources and store more water than existing reservoirs would hold. The answer—a 5,000,000 gallon tank fabricated in General American's shops, trucked to a hard-to-reach spot on the hillside and erected by a General American field crew.

General American won this contract because of ability to fabricate the tank and erect it despite difficulties of terrain. Shops at many locations and strategically-based field erection crews make it possible for General American to do the job efficiently in any part of the country.

We would like to discuss your water storage problems, so why not write or phone the nearest General American office. You'll find *it pays to plan with General American.*

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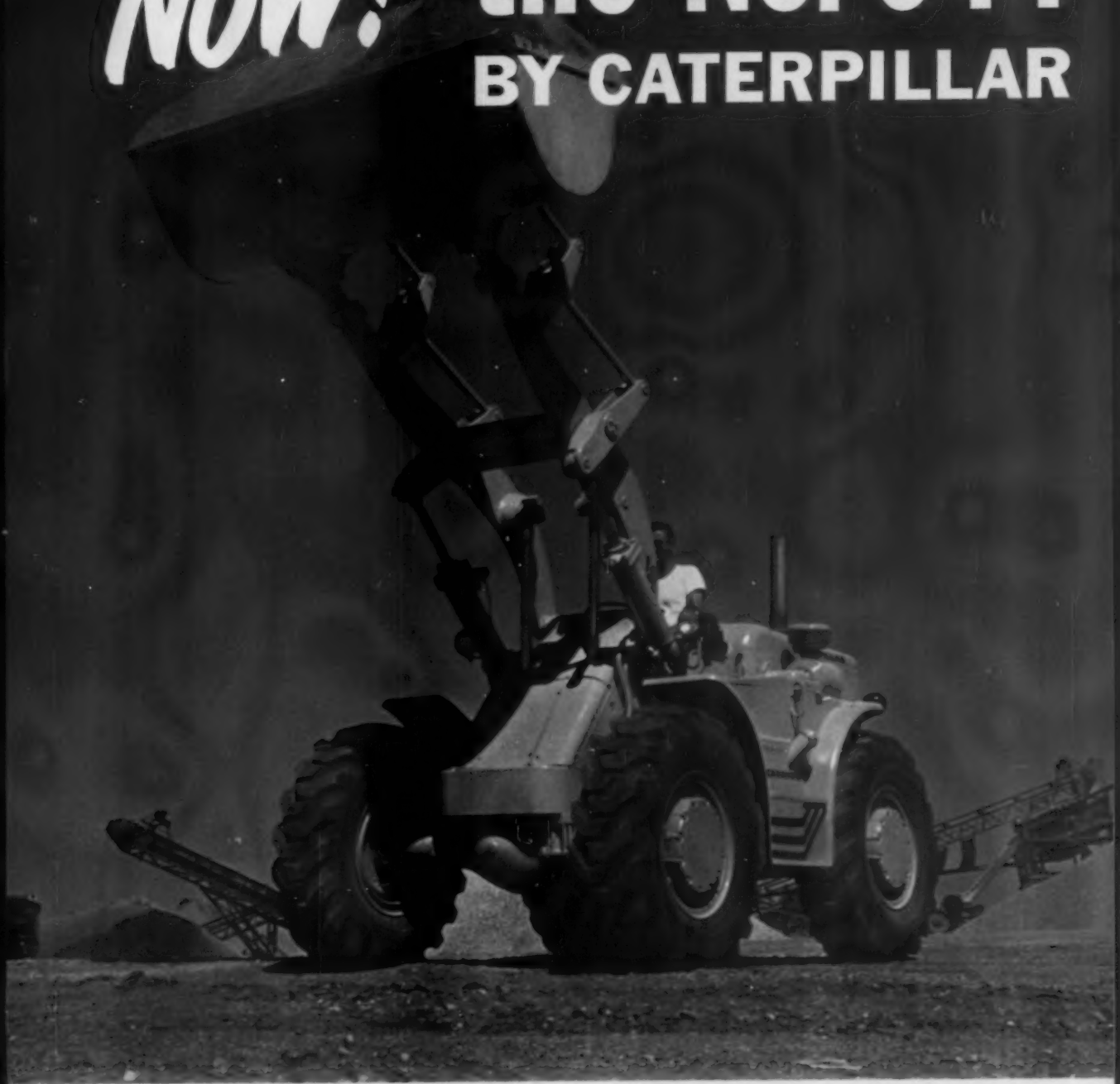

THE *FIRST*
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the No. 944

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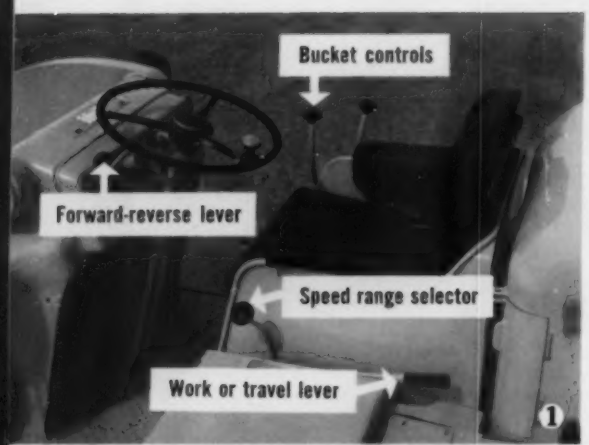

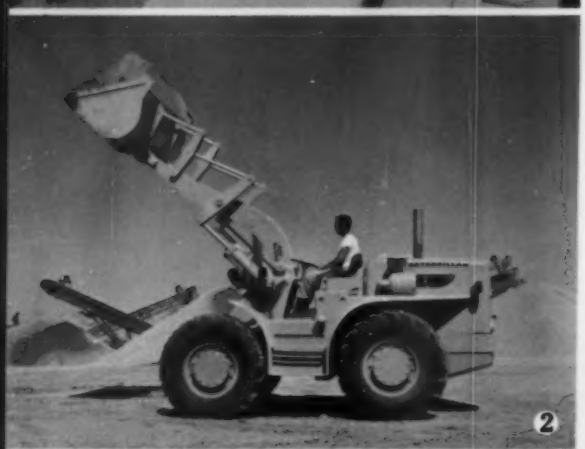

IT'S HERE . . . the Cat No. 944 . . . rated at 2 cu. yd. capacity . . . the first of a completely new line of equipment that will soon include the No. 922 (1¼ cu. yd. bucket) and the No. 966 (2½ cu. yd. bucket).

Watch for these new machines with the bold new design . . . they're ready to bring new standards to wheel loader operation.

Take a look at the No. 944's big, new features . . . features that give it lively response and make it the easiest and safest wheel loader to operate. See it in action at your Caterpillar Dealer. Ask him for a demonstration. See for yourself how the *new design* pays off on your loader jobs.

DESIGNED FOR ACTION . . . with plenty of power for both machine drive *and* bucket hydraulics. Choose from two great, new engines . . . the compact 4-cylinder diesel, turbocharged for maximum efficiency . . . or the 6-cylinder gasoline engine. Both are 105 HP units, fully equipped. Both are made to the same rigid standards. Whatever the requirements of your operation, there's a No. 944 powered to meet your needs.

Tailored to this power is the torque converter and power shift transmission, providing smooth, instant, finger-tip shifting. A full range of work and travel speeds is available on the No. 944. And reverse speeds are 25% faster than forward speeds . . . important in reducing cycle times. Travel Range gives 2-wheel drive for roading . . . Work Range automatically puts power to all 4 wheels.

Machine and bucket controls are located for easy handling(**1**) —the forward-reverse lever is mounted on the steering column.

Both bucket control levers have kick-out devices. The lift control releases at dumping height—the tilt control positions the bucket for digging. And for full bucket loads every pass the 2 cu. yd. bucket tilts back 41° at ground level. The high lift and *extra-long reach* make truck loading faster, easier.

There's plenty of action designed into the No. 944, ready to speed up your loader jobs.

DESIGNED FOR SAFETY . . . in the bold new lines(**2**). Bucket lift arms and pivot points are completely in front of the operator's area. This gives the operator new freedom of movement . . . greater all-around visibility.

Wide steps(**3**) make it safe and easy to get on or off . . . from either side. No need to climb over tires. Fenders provide a handy platform for checking the engine and they protect the operator from rocks and mud(**4**).

The No. 944 brake system gives safer, more precise control(**5**). The *left* brake neutralizes the transmission *as* it stops the machine. This gives superior loading action in extra-tough material.

Traxcavator safety, economy

The *right* brake leaves the transmission engaged . . . for full control when creeping, working on steep slopes or roading downhill.

These and other safety-bonus features give the No. 944 operator greater confidence, greater efficiency.

DESIGNED FOR ECONOMY . . . in the Caterpillar tradition. Sound engineering, modern design, service accessibility, quality construction, responsible parts and service coverage all add up to a new kind of stability—mechanical stability—in the No. 944. The many cost-saving features of this NEW wheel loader will pay off big in your operation!

Offered in a full line of versatile attachments and accessories are forks, cab(**6**) and special buckets, including the *exclusive side dump* that gives the No. 944 added efficiency.

BRIEF SPECIFICATIONS

Horsepower (Net)	105*
Bucket capacity	2 cu. yd.
Bucket reach (@ 7 ft. dump height)	50¾ in.
Over-all width (bucket)	93½ in.
Wheel base	88 in.
Speeds, forward (4)	0-24 MPH
reverse (4)	0-30 MPH
Weight, shipping (with diesel engine)	20,780 lb.
(with gasoline engine)	20,440 lb.

* For comparative purposes, the maximum rating of the D330 Engine used in the No. 944 is 135 horsepower.

THE No. 944 TRAXCAVATOR...

NEW IN DESIGN AND LOADED WITH PERFORMANCE

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There's a wealth of LOADER KNOW-HOW behind the No. 944. It comes from the builders of the best accepted track-type tractor-shovels in the field.

Every feature is designed for *efficient work*. Plenty of horsepower . . . finger-tip shifting . . . smooth, fast bucket action . . . outstanding operator comfort and safety. The result is the bold, new No. 944 . . . the *outstanding* performer in its class!

For complete facts, see your Caterpillar Dealer now.

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A GREAT NEW PRODUCT IN THE CATERPILLAR TRADITION

Safeguard Public Health and Public Funds with the one pipe that has all the features you can trust!

Sewer line failure not only endangers public health, but costs staggering sums in replacement time and materials. That's why Baxley, Georgia, insisted on Vitrified Clay Pipe for its sewer expansion project. Unlike many substitute materials, Clay Pipe does not rust, rot, corrode, disintegrate or deform . . . is completely resistant to the deteriorating action of *all* sewerage gases and acids. Available with joints that meet every requirement.

It is the *one pipe* with all the advantages you want . . . *all* the features you can trust!

PUBLIC OFFICIALS: J. M. Dunn, Mayor
CONSULTING ENGINEERS: Wiedeman & Singleton, Atlanta; T. L. Turner, Resident Engineer
CONTRACTORS: C & L Engineering Co., Augusta

WRITE TODAY for assistance in fitting Clay Pipe into your sewer project . . . and be sure of the lowest cost with the best performance.

Vitrified **CLAY PIPE** *Never Wears Out*

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Scum — the problem of ordinary pools — is washed over the coping and out of the pool into properly located skimmer drains. This eliminates hard-to-drain scum gutters above the water line, saves the cost of formed tile gutters and 5" to 10" of excavation and concrete walls.

A few typical water level pool fittings are shown here, but for complete details, plans and pool layouts, send coupon for Manual SP-6, the "authority" on circulation and drainage for all types of pools.

Series No. 0291-B Deck Trench Grate

Series No. 0297-B Skimmer Grill and Access Grate

Series No. 0298 Skimmer Fitting with Flow Control

Series No. 0730-B Balanceze Supply Fitting

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Commentary on Water and Sewage Treatment

Are Sewage Treatment Plants Becoming Too Mechanized?

R. S. RANKIN

Consultant, Water and Sewage Treatment

FORTY years ago, a typical Imhoff trickling filter plant serving say 25,000 to 50,000 persons had one item of automatic equipment, the dosing siphon, and it produced a high grade effluent. Today, a plant of similar capacity will have from 100 to 200 motors operating special equipment. This is not an attempt to glorify past practice or to remotely suggest that progress in plant mechanization should be discontinued. The questions being raised are whether all this mechanization is being wisely applied, whether the basic function of the plant is sometimes overlooked, and whether all of it aids the operator in producing the required effluent.

Considering that the ultimate success of any treatment process is largely dependent upon the performance of humble organisms, one might ask whether this basic fact is occasionally overlooked in the trends toward adding more apparatus to the modern plant. Possibly a designer at each stage should ask himself the question whether adding another piece of apparatus or even another structure will really give the organisms an opportunity to perform their natural functions more efficiently.

Coarse screenings or trash for decades have been removed at the head end of the plant and it was long considered essential that once removed they should be kept out. Screenings disposal was admittedly a messy and disagreeable task although some enterprising engineers solved the problem by constructing small gas-fired incinerators. The ash, the only residue, was removed with the grit. Now, power driven devices chew up floating solids and put them right back where they came from. The uninformed would probably consider this practice strange. The question might be asked whether it aids or hinders subsequent biological processes. Some genius will eventually evolve a method which eliminates this problem.

The next major step is the removal of settleable solids, but to complicate this operation it is usually done in two stages, one to remove coarse inorganic particles or grit, and the other to remove solids of sewage origin. Separate settling facilities for grit removal were developed in the days of the Imhoff tank and for understandable reasons. This development was eventually mechanized and now there are

Standing water stays fresh... thanks to Armco Radial Gates

Near Grosse Pointe, Michigan, the sluggish Milk River empties into Lake St. Clair. Two pumping stations recently were constructed on the river to facilitate its flow. However, during periods of low flow, the half-mile stretch between the two pumping stations still tends to become stagnant.

To alleviate this situation, four Armco Radial Gates were installed at the pumping station near the mouth of the river. Periodically, the gates are closed and the half-mile section is pumped dry. The gates are then opened and fresh water from the lake is allowed to surge back through the pumped-out area in a flushing action, virtually eliminating undesirable stagnant water conditions.

Armco Gates can solve *your* problems, too. Write us for complete product data. Armco Drainage & Metal Products, Inc., 5310 Curtis Street, Middletown, Ohio.

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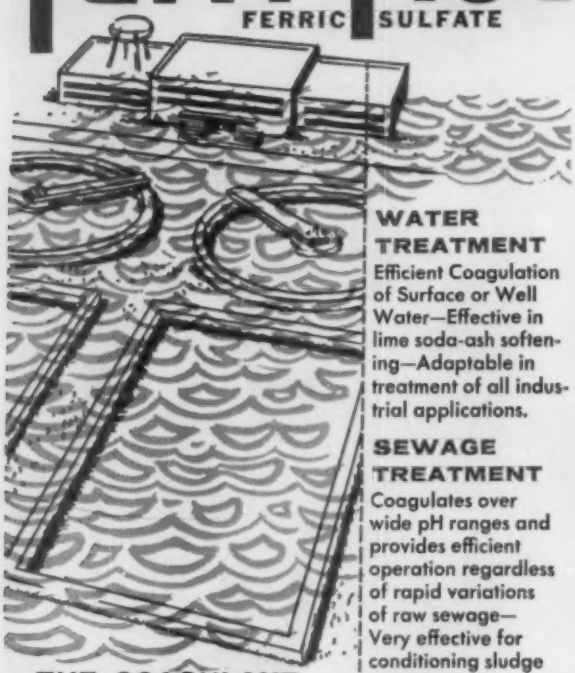

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Efficient Coagulation of Surface or Well Water—Effective in lime soda-ash softening—Adaptable in treatment of all industrial applications.

SEWAGE TREATMENT

Coagulates over wide pH ranges and provides efficient operation regardless of rapid variations of raw sewage—Very effective for conditioning sludge prior to vacuum filtration or drying on beds.

THE COAGULANT WITH THE PLUS FEATURES . . .

Excellent Taste and Odor Control
Increased Filter Runs
Coagulation Over Wide pH Range
Rapid Floc Formation *Turbidity Removal*
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SODIUM SILICO FLUORIDE—for Fluoridation of municipal water supplies. Available for prompt shipment. Inquiries invited.

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available such a variety of devices that at times the basic need, removal of all true sand and grit, seems forgotten. Grit in sewage, particularly from combined systems, is so variable in quantity and character that no economical design of separate grit chamber can be expected to do a job of complete removal at all times. Yet grit removal is essential if the digester volume is to be fully and effectively utilized.

One practical solution is to combine these two stages of selective sedimentation into one. The primary clarifier is used for this purpose and the sludge or underflow is then subjected to facilities for efficient separation of the grit from the sewage solids. Such facilities would be unaffected by rates of sewage flow. The hydraulic cyclone (1) is admirably adapted for this purpose and possibly simple elutriation operating at high rates in a separate tank would also be effective. If the sludge is to be filtered raw, the grit or sand in it does no harm and would even be beneficial.

Primary sedimentation tanks in the long established forms have not been susceptible to much additional mechanization. Changes have been mainly improvements in such things as drives and skimming facilities, although the latter can still be improved. Designers should realize that despite the many theories advanced, the shape of the tank has little, if any, effect on solids removal. Selection of shape should be governed by economics, including not only first cost but maintenance, sludge and scum removal facilities, and the ease with which the tank can be operated. Recent arbitrary requirements for additional length of weir not supported by facts should be discontinued. Any influence of primary tank performance on final plant effluent is due to more fundamental factors than weir length. Many of the earlier activated sludge plants with no primary settling whatsoever turned out excellent effluents.

In the secondary treatment section, trickling filter distributors have experienced only minor changes in the last 15 years and there is little opportunity for excess mechanization. A minor factor increasing cost but without proven need on high rate filters is the occasional insistence on 4-arm distributors where two arms will handle the flow. Much more costly is the insistence on low rate filters where high rate filters will do an adequate job. In this connection Ingram (2) is in the process of demonstrating that present day high rate filters in a few years will be considered low rate. What are now called low rate will probably disappear. Filter underdrains now have probably reached the peak of efficiency although when rates are eventually increased to 75 or 100 mgad as seems likely, some change may be needed.

Treatment by the conventional activated sludge process, despite the confusing discourses on the subject, is not as complex to design as it might appear. The major problem confronting the designer is the selection of an adequate aeration system and this has been a problem since the earliest plants. Some systems require efficient air cleaning equipment while others do not. Porous tubes or plates occasionally require cleaning but if a spare aeration tank is provided or available at the time, this operation need not require special equipment. Tank shapes for conventional treatment have changed little in the past 20 years.

Variations from the conventional activated sludge process often need additional equipment requiring skill to operate and maintain. These variations include modified aeration, bio-oxidation or bio-floc-

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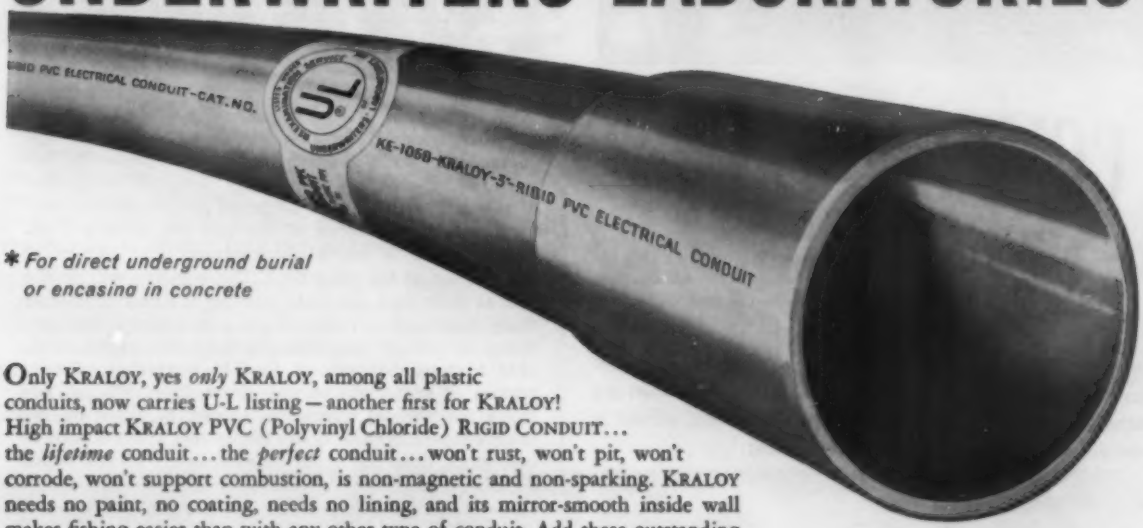
FIRST PVC RIGID CONDUIT INSPECTED AND PASSED BY UNDERWRITERS LABORATORIES*



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Only KRALOY, yes *only* KRALOY, among all plastic conduits, now carries U-L listing—another first for KRALOY! High impact KRALOY PVC (Polyvinyl Chloride) RIGID CONDUIT... the *lifetime* conduit... the *perfect* conduit... won't rust, won't pit, won't corrode, won't support combustion, is non-magnetic and non-sparking. KRALOY needs no paint, no coating, needs no lining, and its mirror-smooth inside wall makes fishing easier than with any other type of conduit. Add these outstanding features to KRALOY's extreme light weight (see chart below) and you have the *ideal* conduit... ideal for direct burial and slab work. Installation costs can be cut *drastically* with light weight KRALOY PVC RIGID CONDUIT. Consider the dollars to be saved in handling and installing U-L listed KRALOY CONDUIT Cat. No. KE-1058 versus steel, *versus even aluminum conduit:*

KRALOY PVC CONDUIT is sold only through wholesale electrical supply houses.

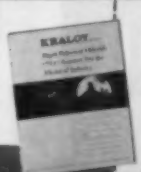
NOTE WEIGHT COMPARISON — KRALOY PVC vs. ALUMINUM vs. STEEL CONDUIT

U.L. required minimum weight per 100 ft. including couplings, lbs.

K-59-29

Trade Size	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"	5"	6"
KRALOY PVC	15.0	20.0	29.0	40.0	47.0	63.0	101.0	131.0	159.0	187.0	253.0	326.0
ALUMINUM	27.4	36.4	53.0	69.6	86.2	115.7	182.5	238.9	287.7	340.0	465.4	612.9
STEEL	79.0	105.0	153.0	201.0	249.0	334.0	527.0	690.0	831.0	982.0	1334.0	1771.0

For complete information on KRALOY PVC CONDUIT and installation directions, mail the coupon or write to Kraloy Plastic Pipe Co., Inc., Dept. PW-3, 402 W. Central Avenue, Santa Ana, California



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culation and are designed to produce a specific type of effluent or reduce the cost of operation or both; but the more deviations from the conventional, the more the skilled attention needed. Considering the constantly increasing number of sewage plants, the training of competent operators becomes a serious problem; and without trained operators, obtaining the expected efficiency from such innovations becomes questionable. Maintaining proper environment and food supply for the busy organisms should be the ever present objective of the operator and complicated steps in operation should be avoided except where adequate skill is available.

Sludge treatment in the average sewage plant now is tending to become a highly involved operation. Even raw sludge is now occasionally treated by adding chemicals and vacuum filtration. Incidentally, several years ago dewatering of raw sludge by a continuous centrifuge was successfully demonstrated, but in those days it had no appeal. A centrifuge requires no chemicals or auxiliary equipment and is lower in cost than any vacuum filter equipment. If raw sludge dewatering is to become a continuing practice, the centrifuge again deserves renewed attention.

Where typical sludge digestion is to be practiced, the inexperienced designer has such an array of apparatus to choose from he must be completely bewildered. He should constantly keep in mind that digestion is a process of bacterial decomposition performed in the absence of air and the principal requirement is a warm environment and plenty of food served at the right time. The bacteria will do the rest at their own pace and nothing is likely to change their habits. For most efficient operation, homogeneous mixing of the tank contents will make available a greater supply of food to a greater concentration of organisms in any given time. Mixing, being a mechanical operation, should be done by the most efficient means. Scum formation, often a bane to operators, does not occur in adequately mixed tanks. Feeding a digester to obtain maximum performance requires small charges of raw sludge at short intervals rather than infrequent heavy amounts. After an allotted time interval, the digested sludge is displaced into a holding tank for storage until ultimate disposal. With such a simple operation as the only requirement, it is difficult to understand the need for the large network of piping and valves found in some installations. They must confuse the operator and serve no useful purpose. An inlet, outlet, and drain for each tank will provide all needed facilities for handling the sludge. Heating the digester contents can be combined with the raw sludge feeding or by circulating a portion of the sludge. If buildings are to be heated a separate boiler makes a more efficient installation.

After digestion, the sludge may be dried on sand beds which have not changed in design for decades. If condensed facilities are necessary, additional equipment is required—elutriation tanks, vacuum filters with a minimum of 10 items of apparatus; and if mechanical drying follows, still another group of items must be added, each requiring careful evaluation.

This is good business for the equipment purveyor and in large plants much or all of it is justified. On the other hand a careful cost analysis will prove that many plants cannot well justify such facilities for the job to be done. Frequently duplicate units can be avoided by stocking a few spare parts. Operators

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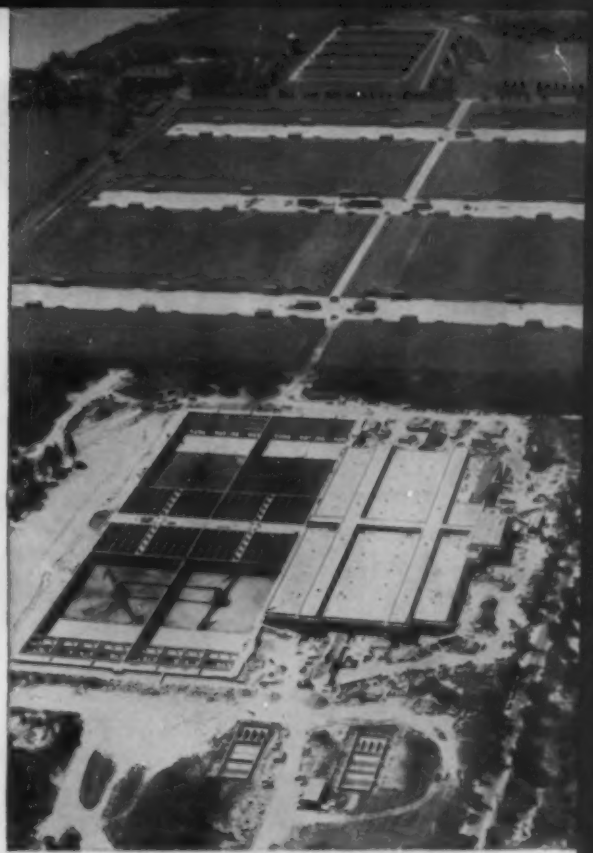

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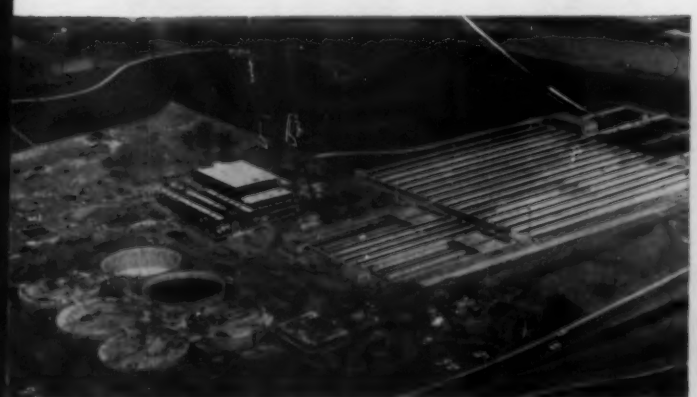

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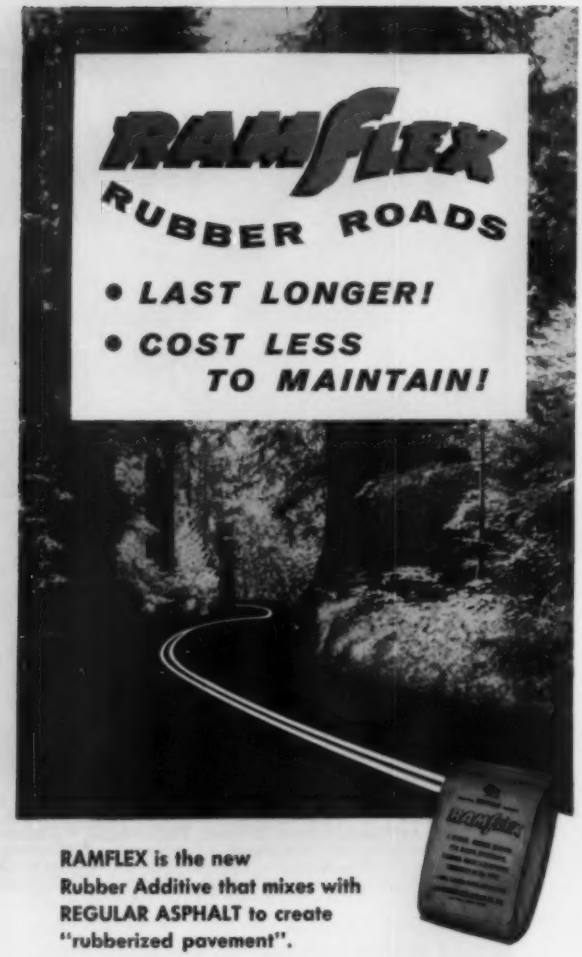

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whose principal function should be to turn out an effluent of specified quality often have to double as mechanical and electrical engineers, a role for which they are seldom qualified or paid. Progress in mechanization is desirable, but it must always be justified: Is it going to improve the effluent? The designer should consider carefully each item of equipment to make sure it contributes its full share to the plant performance.

References

1) Replacing Conventional Grit Chambers. R. S. Rankin. PUBLIC WORKS, January 1959, Pg 68.
2) An Investigation of the Mechanics of Controlled Filtration. William T. Ingram. *Jrnl. Sew & Ind Wastes Assn.* Vol 31, 1959, Pg. 1147

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Saline Water Conversion Research Contracts

New research contracts, or contract renewals, awarded by the Office of Saline Water Department of the Interior, since July 1, 1959, total $466,339. The research sponsored by these contracts is designed to uncover necessary scientific data to permit the development of new processes, or improvements on existing processes, in order to produce converted sea or brackish water at lower cost than is now possible.

Among the contract and contract renewal recipients are Battelle Memorial Institute, Carrier Corp., Cornell University, Curtiss-Wright Corp., Franklin Institute, Georgia Tech., Lummus Co., Dr. Donald F. Othmer, Brooklyn Tech., Whiting Corp., Syracuse University Research Institute, Ionics Inc., Radiation Applications Inc., and University of Oklahoma Research Institute. The contracts cover studies on solar distillation, rotary vapor compression distillation, direct freezing, atomized suspension techniques for brine disposal, vapor reheat flash distillation, saline conversion using gas hydrates, control of scaling and corrosion, application of ion restraining membranes, and electrical control of adsorptivity of porous conductors.

Contracting for Custodial Services

By preparing precise specifications for custodial and janitor services, Columbia, S. C., was able to call for bids on this type work. The lowest bid, which was accepted, was for 3.1785 cents per square foot for servicing the City Hall. The annual cost will be $6,118. For this payment, the contractor will sweep, damp mop, wash and wax floors; clean carpets; clean rest rooms; wash window and door panes and window sills; dust and polish furniture; and clean lighting fixtures. The contractor will furnish equipment and supplies and provide for insurance, public liability and workmen's compensation.

Nevada Highway Construction Costs

The Nevada State Highway Department cost index showed lower costs for 1959—104.6 as compared to 113.3 for 1958 and 100 for 1955. Relatively few contracts were awarded in 1959—24 for 131 miles totalling $7,560,860—and there were numerous bidders.

Average 1959 cost of road excavation was 39.7 cents per cubic yard against 53.5 cents for 1958; borrow was 23.4 cents against 24.1; plant-mix surface $2.53 per ton vs. $2.49; class A and AA concrete $66.86 per c.y. vs. $71.37; reinforcing steel 12.9 cents per pound vs. 14.2 cents; and 24-in. CMP $6.61 per ft. vs. $6.73. Gravel and liquid asphalts were up slightly.

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Rubber PIPE GASKETS

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Gumbo! . . . wet, sticky and unstable . . . that's what faced contractors installing Baton Rouge's Longwood Drive Outfall Sewer. And the trench for the line was more like a canyon than a sewer ditch.

How were the terrific excavating costs to be offset . . . the job to be done in reasonable time . . . water-tight joints to be assured? . . . Here's how the designers' specification for TYLOX RUBBER GASKETS laid all three problems by the heels at once:

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PROJECT: Longwood Drive Outfall Storm Sewer for City of Baton Rouge, La.

ENGINEERS: Edward E. Evans, Consulting Engineer, Baton Rouge, La., and Ray W. Burgess, Director of Public Works, Baton Rouge, La.

CONTRACTOR: J. H. Jenkins, Contractors, Inc., Baton Rouge, La.

PIPE: 72" T & G Reinforced Concrete Pipe with TYLOX Rubber Gaskets, manufactured by Anderson-Dunham, Inc., Baton Rouge, La.

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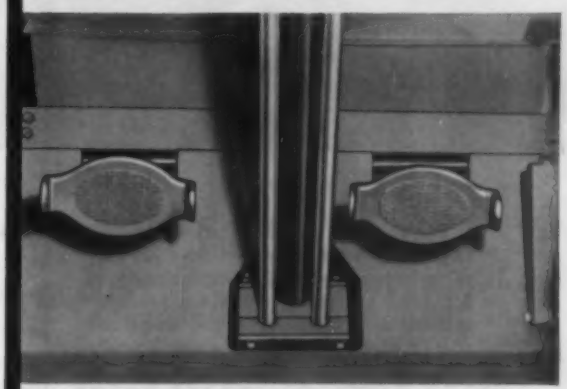

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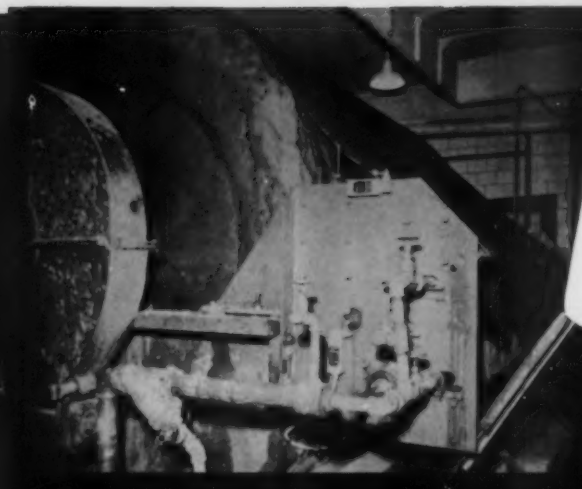

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Inductive Coordination of Power and Communication Circuits

A description of the basic principles of inductive interference, which may cause undesirable noise in telephone circuits which are parallel to power distribution circuits. Steps that may be taken to eliminate such interference are suggested.

BRUCE J. ENNIS
Principal Engineer,
Burns & McDonnell Engineering Co.,
Kansas City, Missouri

A PROBLEM frequently arising in the operation of an electric power distribution system lies in the interference imparted to communication circuits from an adjacent and paralleling power circuit. In severe cases, the induction from power lines to communication circuits may render service from the latter unsatisfactory, if not intolerable. In the interest of providing high quality service from both the power and the communication utilities in a given community, the adherence to certain basic principles of inductive coordination will often alleviate or eliminate entirely conditions leading to substandard communication, without resorting to expensive remedial measures.

Generally speaking, inductive interference is composed of the three elements of influence, susceptiveness, and coupling factors. Inductive coordination is the joint effort of the power and communication utilities to minimize the detrimental effects of these interference factors.

Influence factor pertains to the inductive effects of the power circuit and its equipment on adjacent communication circuits. Susceptiveness factors relate to the sensitivity or responsiveness of the communication circuits to inductive interference, and coupling factors pertain to the mutual relationship, spacing, separation distance, length of exposure, etc., between the power and communication circuits.

Power circuits impart two types of inductive effects on adjacent communication circuits. When alternating current flows in the power conductors, a pulsating magnetic field is produced which induces a voltage in the telephone wires by the phenomenon of magnetic induction. This voltage, in turn, causes a current to flow in the connected telephone receivers, manifesting itself as foreign noise. In a similar manner, the high voltages impressed on power circuit conductors produce a pulsating electrostatic (or electric) field which induces a voltage in the telephone wires by electrostatic induction. From these causes, it is apparent that the more the current flowing in a power circuit and the higher the voltage at which it is operated, the greater will be the effect on paralleling communication circuits.

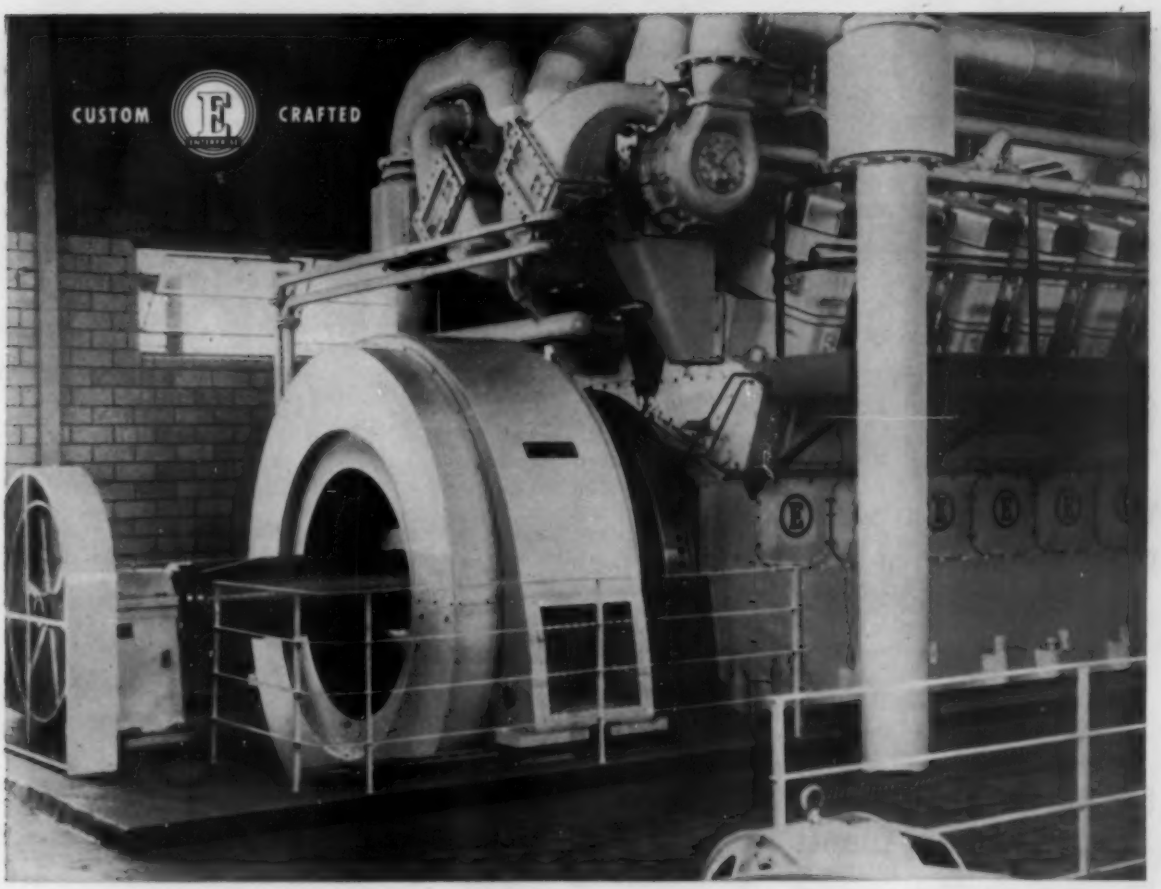
Communication circuits operate on low voltages and with a very few milliamperes of current. Therefore, the foreign voltage and resultant current induced in such an inherently low-power circuit from a paralleling power circuit operating at high voltage, or carrying large amounts of current, will give rise to an objectionable hum and increase in noise level on the telephone receivers connected in the communication circuit. The stray currents induced in telephone lines from the harmonics of a paralleling power circuit may exceed the energy supplied to the lines for the transmission of speech. Therefore, it is apparent that poor service may be expected where inductive coordination is lacking.

The noise imparted to telephone receivers by magnetic and electrostatic induction will vary in loudness and in pitch in accordance with the strength and the frequency of the harmonics present in the initiating power system conductors. The ordinary fundamental sine wave frequency of 60 cycles per second in power conductors does not impart nearly the noise level in exposed telephone circuits as do the harmonics in the range of voice frequencies such as are produced in power plant generators and in the exciting currents of substation and distribution transformers.

The balanced, or line-to-line telephone influence factor or "TIF" of the power circuit voltages and currents is the relative interfering effect on a telephone circuit caused by the odd, non-triple harmonics such as the 5th, 7th, 11th, etc., which may be present in the wave form. It is 11,600 times as great at 1020 cycles (17th harmonic) as it is at the fundamental frequency of 60 cycles. This is due principally to the fact that telephone receivers have a resonant point in the approximate range of 1000 to 1100 cycles, for operation in an ordinary voice range between 250 and 2500 cycles per second.

Residual telephone influence factor is the relative interfering effect on a telephone circuit caused by the odd triple harmonics in the wave form, such as the 3rd, 9th, 15th, etc. In the harmonic analysis of the phase to neutral voltage on the bus in a 4160 volt diesel engine generator power plant, typical readings indicate a TIF contribution of 16.0 for the 15th harmonic, ranging down to 1.8 for the 3rd harmonic and to 0.6 for the 27th harmonic.

Most power distribution circuits, for reasons of economy, are in the form of exposed conductors carried on pole mounted cross arms. The closer the spacing of the conductors, the less will be the effect, on paralleling telephone circuits, of the balanced currents in a three phase power circuit, or of the currents in the two wires of a single phase circuit. This is due principally to the fact that the resultant magnetic field effecting the telephone circuit is caused preponderantly by the current in the closest power conductor. Therefore, in severe cases of exposure caused by the non-



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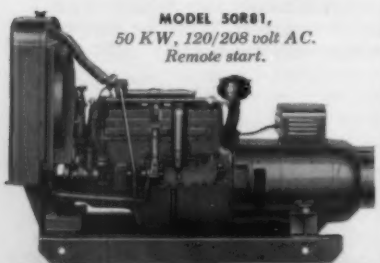

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triple harmonics, it might be necessary to consider the use of suspended aerial cable, in lieu of open wire power conductors, to reduce the influence factor of the power circuit in certain sections of line where coupling is the greatest.

In the case of the triple-harmonic residual currents flowing in a power circuit, the spacing of the three phase conductors has less effect on the influence factor, since, at any given instant, the currents flowing in each conductor are in phase and are of equal magnitude, with the three line wires serving as one conductor, and the neutral wire or earth current path serving as the other conductor.

In ordinary distribution practice, power conductors are seldom transposed. On the other hand, open wire telephone conductors are often transposed, to equalize coupling factors for the individual wires, and, of course, telephone conductors installed as twisted pairs in cable are, in effect, continuously transposed.

In a typical three phase, four wire, grounded wye power distribution system operating at 4160 volts or 13,200 volts, certain factors are inherently present which give rise to the flow of triple harmonic residual currents unless measures are taken to prevent their influence on adjacent communication circuits. As a case in point, assume that a diesel engine generator, with its neutral grounded, is connected to a distribution pole line feeder which extends parallel to a telephone toll circuit for a distance of several blocks. Let it be assumed, further, that a step-down industrial substation transformer bank is at the end of the feeder (beyond the point of parallel exposure between the power and telephone circuits) and that the transformer bank is connected delta on its secondary side and grounded-wye on its primary side.

With the bank's primary neutral connected to ground, the triple harmonic currents flowing out of the generator will be carried along the distribution phase conductors (giving rise to magnetic induction interference in the telephone circuit) and thence through the substation transformer bank neutral to ground, to return through the earth and the feeder neutral wire to the generator neutral. In this case, a low impedance closed circuit path is provided for the flow of triple harmonic currents. To eliminate this condition, it is only necessary to disconnect the grounding connection to the transformer bank's neutral and operate the bank with a primary floating neutral, and thus disrupt the path for the flow of detrimental residual currents.

In the case cited above, another solution which would eliminate the flow of triple harmonic currents in the distribution pole line wires would be to use a step-up transformer bank connected delta on the generator side and wye on the line side. Such a transformer connection might be employed, for example, in supplying a 13,200 volt feeder from a 2400 volt or 4160 volt generator bus. In effect, any triple harmonic currents produced in the generator will circulate in the closed delta winding of the step-up transformer and thus prevent the transformation of such currents in the high voltage line side windings.

Finally, the installation of a suitable wave trap in the neutral lead of the generator would prevent the flow of any triple harmonic currents produced in the generator. Such a trap consists of an inductance tuned in parallel with a capacitance to form a resonant circuit at the harmonic frequency to be suppressed.

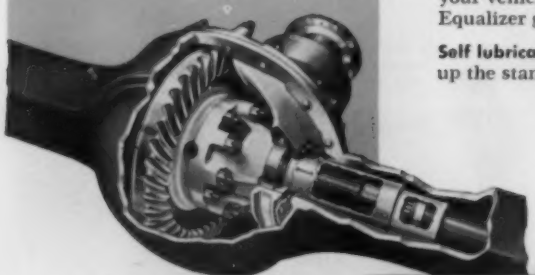
The very nature of possible sources and causes of interference between power and communication circuits is so complex and interrelated, that the proper and economical solution of inductive coordination requires close cooperation and joint study by the power and telephone engineers. In cases of reported trouble on communication circuits, it is suggested that the power distribution engineer request the telephone engineer to make harmonic analyses on both the telephone and power circuits, with a noise measuring set analyzer, and assist in the determination of the TIF contributions of the various balanced and residual harmonic voltages. With such an analysis, conducted at the power plant and at trouble spots in the joint distribution systems, the problem may be narrowed down and a solution may be determined for elimination of the interference at minimum expense for the two utilities. All such studies should recognize the need for telephone circuit protection against the possibility of fundamental frequency 60 cycle induction from momentary faults occurring in the power system circuits.

For solutions to specific problems of inductive coordination, reference may be made by the telephone and power engineers to design and operating criteria such as "Bell System Practices" of the American Telephone and Telegraph Company Standards.

NEW ROCKWELL TRACTION EQUALIZER...

puts the action where there's traction!

Available with Timken-Detroit® Axles for safer, surer performance... on or off the highway!



Applies driving force to wheels with best traction. The Rockwell Traction Equalizer provides a substantial increase in tractive effort to the wheel with the best road adhesion. It is effective on a vehicle even if one pair of the driving wheels has *no* traction!

Safer, surer operation. A truck equipped with the Rockwell Traction Equalizer is easier to control on curves, slippery pavement and soft ground. The tendency of a vehicle to swerve when one wheel suddenly loses traction is eliminated because wheel spinning is reduced.

Constant actuation. The Rockwell Traction Equalizer doesn't depend on the driver to start it working. It is effective whenever one wheel has the tendency to turn faster than the other.

Tailored for effectiveness. With multi-drive axle vehicles, each axle may be equipped with Traction Equalizer units. No matter where your vehicles operate—on or off the highway—the Rockwell Traction Equalizer gives your vehicles better traction.

Self lubricating. The Rockwell Traction Equalizer automatically picks up the standard axle lubricant and works it through the unit.

Less maintenance. The Rockwell Traction Equalizer normally requires no maintenance between axle overhaul periods. It also cushions heavy impact loads upon tires, shafts and gears.

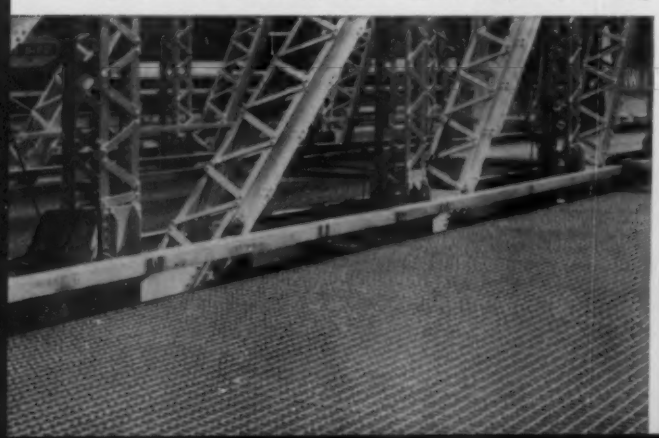
Another Product of...

ROCKWELL-STANDARD CORPORATION

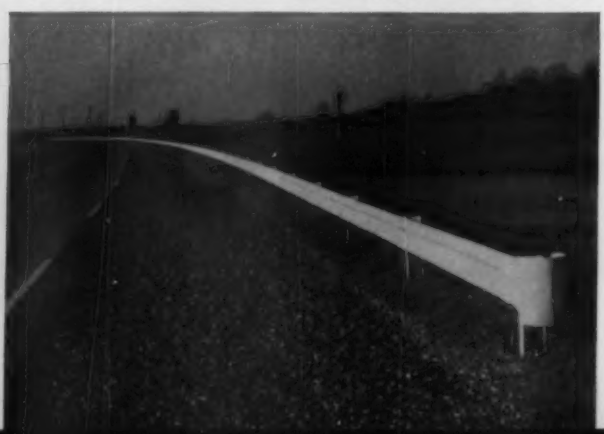
ROCKWELL R STANDARD

Transmission and Axle Division, Detroit 32, Michigan

USS AmBridge I-Beam-Lok is a sturdy, lightweight bridge flooring. It installs quickly and easily with few interruptions. The filled type is available in units 6′ wide and up to 49′ long that apply directly to stringers on spans from 6′ up to 8′ centers. The open type is also available for spans up to 4′ long.



USS AmBridge Highway Beam Guardrail and Posts help safeguard traffic. This rugged, flexible steel beam guardrail is highly visible. It bolts easily but firmly to steel posts and is available in 25′ lengths to minimize splicing.



This is a people pipe

This passenger underpass was fabricated from USS AmBridge Sectional Plate—normally used for drainage structures. It's buried 10-feet below the railroad tracks at the Philadelphia Electric Company's Eddystone Station near Philadelphia, Pennsylvania. □ USS AmBridge Sectional Plate was an ideal choice for this underground passageway, because it won't crack. Won't break. It's a permanent steel structure. It was easy to erect . . . there was no need for forms. AmBridge Sectional Plate comes in a complete range of sizes. And, it's fabricated to meet all federal and state specifications. Write or contact any one of our offices for literature and information on American Bridge Highway Products.

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USS

Grant County, Wisconsin, buys its first tractor-scraper... all-purpose Cat No. 619 with No. 442 Scraper

"This rig has more features than anything we looked at in its class. More power, speed, maneuverability"

George Hudson, Construction Supt.

To keep an 8 to 10 mile per year road building program on schedule, Grant County needed a fast, compact mobile earthmover for use on longer hauls and larger yardages. After testing competitive rigs, a demonstration sold the county on a Cat No. 619 with matching No. 442 Scraper. Reason: it has more "bonus features" than any other machine in its class.

First assignment for the No. 619—relocating a half mile of road to eliminate a bad curve. 14,000 cu. yd. had to be removed to make a 14-ft. cut. The job proved to be a stop-and-go affair—haul distance 375 ft.—with tough material—sand, rock and clay so stubborn that much of it needed ripping. The No. 619's lugging ability and easy handling on sharp turns pay off. And on longer hauls, Superintendent Hudson reports the No. 619 "climbs up a 5% grade in 4th gear with a good load."

Here are some reasons why the No. 619-No. 442 is an "all job" rig loaded with performance. A Turbocharged Cat Engine delivers 225 HP and high torque rise for fast acceleration and lugging power under capacity loads. The LOWBOWL Scraper handles 14 cu. yd. struck . . . 18 cu. yd. heaped. The No. 619-No. 442 team has 30 MPH *usable* operating speed . . . hugs the ground for roadability found in no other 2-wheeled earthmover of its capacity. Newly developed 2-jack hydraulic steering gives effortless maneuverability yet retains "feel of the road" control. This advance steering permits full 90° turns in a diameter of 30 ft.

Get the full story on this hurry-up, all-purpose rig from your Caterpillar Dealer. Ask for a demonstration under the job conditions you face. See why this machine is the wisest investment for your taxpayers' money.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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NO. 619-NO. 442
FOR "ALL JOB" VERSATILITY

MARCH 1960 • VOL. 91, No. 3

PUBLIC WORKS MAGAZINE

DIATOMITE FILTRATION WORKS For PALMYRA

WILLIAM E. GERMAN

Water Treatment Plant Operator,

Palmyra, New York

IN THE EARLY 1950's the Village of Palmyra, N. Y., was facing the widespread problem of inadequate water treatment facilities. An existing slow sand filter installation of 170,000 gpd maximum capacity was unable to keep up with the growing per capita water demand. Equipment in our plant was outmoded and its location, on a hill in the woods, was relatively inaccessible. Accordingly, expansion of the existing plant or location of a new plant at the same site was considered impractical.

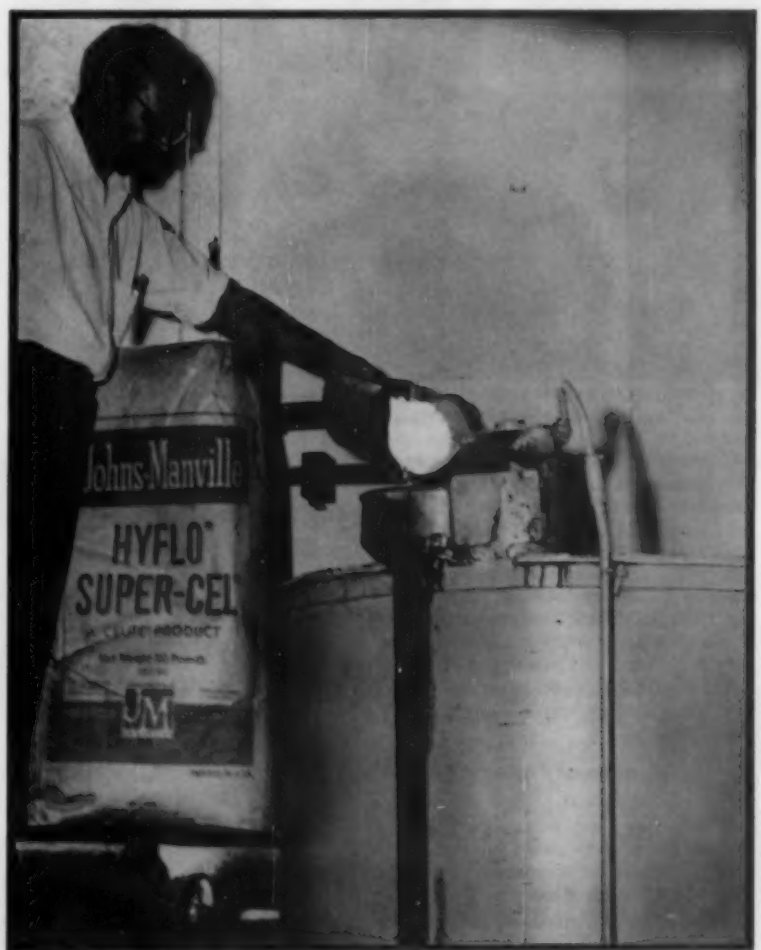
The source of raw water for Palmyra's supply is Lake Canandaigua, about 16 miles south of the Village. This source was chosen rather than the much nearer Lake Ontario because the former's elevation, which is 195 feet above the plant level, provided ample head to permit gravity flow to the plant. When the old plant was constructed the entire system, including treatment, was designed to operate on the head available from this source. However, growing demands of local industry, which use up to 1.5 mgd of untreated water, reduced pressures at the plant to about 20 psi and required the installation of two 400-gpm raw water pumps.

Quality of the raw water supply is generally good, with turbidities averaging 1.6 mg/L, although following storms the turbidity may rise to 120 mg/L. Both inorganic material and algae are present.

Water Requirements

At the present time, water demand by Palmyra's 3100 domestic consumers ranges from 190,000 gpd in the winter to peaks of 550,000 gpd in July and August.

When it became evident that a new plant was needed, various treatment methods were considered. A site adjacent to the operator's home seemed desirable since the raw water line was already in this location and a nearby creek provided for wash water disposal. However, this location in a residential area necessitated a very compact plant. A diatomite filter installation was decided upon after similar in-



● **FILTER AID slurry tank, 300-gal. capacity, is filled daily. Slurry contains about 0.4 lb. per gallon of diatomite. Precoat for each filter uses 30 pounds of diatomite; body feed rate averages 4 mg/L filter aid for each mg/L of raw water turbidity.**

● **INSTRUMENTATION consists of the rate of flow recorder at top; storage level indicator which controls plant operation, center; and pressure recorder, at bottom.**

stallations in the general area were observed and cost estimates obtained.

The plant, designed by Meloy Smith, Consulting Engineer, Rochester, N. Y., is housed in an attractive one-story building measuring 36 by 28 feet. Design capacity is 500,000 gpd, with provision for easy expansion to 750,000 gpd. Total installation cost, exclusive of the two 400-gpm raw water pumps, was about $47,000.

Layout and Piping

Layout is convenient and efficient. A main filter room houses two diatomite filters, with room for a third unit if needed. Adjacent to this is a room for filter aid storage and slurry preparation, with another room for chlorination and fluoridation equipment. Laboratory and office facilities installed at the rear of an attached two-car garage complete the physical plant layout.

Water and waste line connections to the new plant were relatively short. The 8-inch cast iron raw and treated water mains totaled about 130 feet in length and the 12-in. drain line measured 90 lineal feet.

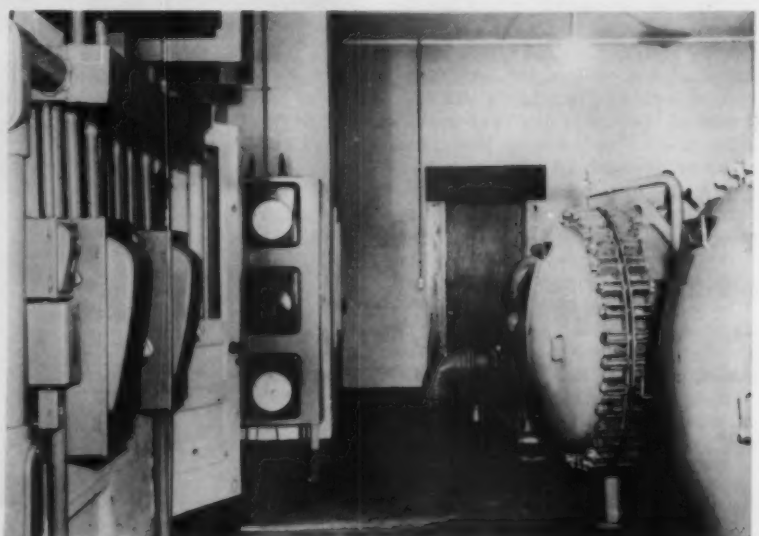
8-inch piping is used for the raw and filtered water headers and 4-in. for the backwash header. Plug valves are provided for control of filter operations. Body feed lines may be flushed with a clear water supply. A Cla-Val backflow preventer is installed on the discharge header from the pumps to prevent reverse flow from the storage tank.

Equipment Details

The main filter installation consists of two 200-sq. ft. Sparkler Model SCJ (33-18) diatomite filters, with circular perforated stainless steel leaves covered with Orlon cloth. Design capacity is 1 gal./sq. ft./min. Easy access is provided for all valves used for precoating, filtering and backwashing.

Both body feed and precoat are supplied from a 300-gallon slurry tank which is filled daily. Body feed is delivered at a manually controlled rate by a single piston Madden diaphragm pump. Precoat is fed by an eductor. Other treatment equipment at the plant includes a Wallace & Tiernan chlorinator and a small proportioning pump which feeds hydrofluosilicic acid at a controlled rate to give 1 mg/L fluoride content in the treated water.

Operation of the plant is controlled automatically by an instrument which indicates the storage level in a 1,000,000-gal. treated water reservoir. In addition to this instrument,



● **INTERIOR view of filter room. Filters are shown at right; door in background leads to the office and laboratory. Door at left is to storage room for filter aid.**

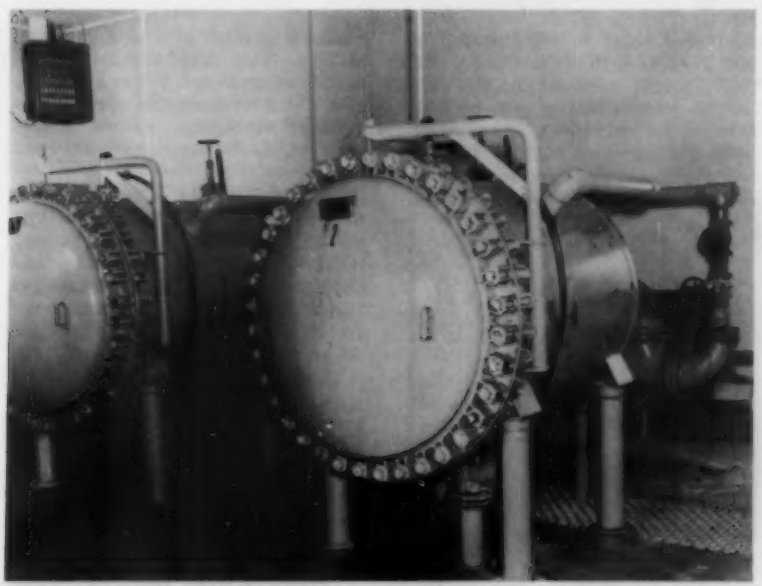
the plant is provided with a totalizing flow recorder and a record of pressure in the raw water line entering the plant.

Operation

At the start of each cycle, the filters are precoated with 0.15 lb./sq. ft. of Johns Manville Hyflo Super Cel, or a total of 30 lbs. per filter. This precoat is supplied by means of an eductor as a slurry containing about 0.4 lb. (about 5 percent) of diatomite per gallon. Following the precoat operation the filters are run to waste for three to four minutes, or until examination of an effluent sample shows no sign of filter aid particles.

During the filter run a body feed of the Hyflo Super Cel is fed as a 5 percent slurry by the diaphragm pump. Normally the rate is about 4 mg/L of filter aid for each mg/L of raw water turbidity. The body feed rate is controlled manually and is checked two or three times daily.

● **PORTION of laboratory interior with the author making a turbidity determination. Other equipment shown is used for testing the fluoride content of the water.**



● **TWO 200-SQ. FT. diatomite filters are installed with space for another unit.**

Runs continue until the pressure differential through the filter has reached 10 to 15 psi. Cycle lengths vary with the amount of turbidity in the raw water, but generally each filter run lasts two to four days.

The filters are provided with built-in jet sprays for backwashing and this operation can be completed in about 15 minutes. Between 500 and 1000 gallons of treated water are used to backwash each filter. Filter cloths are scrubbed and cleaned every three or four months. Outside of this, only routine daily operating maintenance has been required.

Daily records include chemical filter aid consumption, volume of water treated, turbidity and chlorine residual. Raw water turbidity is checked twice a day by a Hellige turbidimeter. Since the effluent turbidity is normally too low to be read on this instrument, checks are made only two or three times a week except during short periods of high turbidity of the raw water, when the effluent is checked at least daily.

Since plant operation is controlled by the water level in the storage reservoir it was necessary to take precautions against a possible cross-connection due to slippage of the filter cake during standby. This was accomplished by the use of a small recirculating pump which runs continuously at the rate of 30 gpm. In case of power failure a valve on the filter effluent line opens automatically to drain to waste, thus holding the filter cake in place.

The plant has now been in continuous operation for more than three years, and it has lived up to its expectations in every way. Operation has been very efficient, in great contrast to the old plant which required constant supervision and maintenance. A high quality effluent has been produced at a very low operating cost, as shown by the following figures which are based on an average total daily flow of 300,000 gallons:

Costs per 1,000 Gallons

Chlorine	0.15¢
Hydrofluosilicic Acid	0.01¢
Filter Aid	1.08¢
Power	2.24¢
TOTAL	3.48¢

Installation of a municipal diatomite water filtration plant at the Village of Palmyra has proved to be a very successful solution to our water problems. The compact, efficient plant has provided for our increased water demand at low initial and operating costs.

The Use Of Epoxy Resins On The New Jersey Turnpike

● TWO components of the epoxy resin are blended on the job as needed. Material must be used promptly after mixing.

● SURFACE to be patched is primed with the mixture. Dry sharp stone or silica sand is then mixed with the resin.

HAROLD W. GOLDBERGER
Assistant Engineer of Maintenance, New Jersey Turnpike Authority

FOR THE PAST few years, many spalled areas have appeared in the reinforced concrete bridge decks and concrete slabs at Interchange Plazas and Service Areas of the New Jersey Turnpike. Investigation of the failures revealed that reinforcing steel was too close to the surface of the concrete. In some cases the steel was within ½" of the surface. Where that condition existed, hair line cracks appeared in the concrete deck surface. In time, these cracks became wider due to the use of rock salt for snow and ice control. Brine formed by melting snow and the rock salt found its way into the cracks and onto the reinforcing steel. The steel rusted under these conditions, expanded, weakened the concrete and finally a spalled area was formed. The size of the spalled area varied from 2" x 2" to as much as 18" x 18" and from ½" to 1½" in depth.

In addition to the spalled portions, areas of concrete surface were found to contain polished aggregate. These areas were the result of mechanical grinding in 1951 after having been checked by means of a straight edge and found to contain irregularities measuring more than ⅛" vertically. The surface was made smooth and even by grinding to comply with the specifications. The grinding was completed prior to the opening of the Turnpike to vehicular traffic. The grinding removed the top surface of cement mortar and perhaps some of the cementing action which holds the aggregate together to form a dense mass. Heavy traffic on the roadway surface plus the presence of brine from snow and ice control measures combined to remove more of the mortar from the surface and resulted in highly polished aggregate at each mechanical ground area.

● TYPE of failure caused by reinforcement too close to the surface. A cold bituminous patch did not succeed.

● CONCRETE patch was made in the conventional manner, nevertheless, spalling continued around the patch.

Hair line cracks were found in the surface of many reinforced concrete slabs. While these cracks may not seem to be dangerous, they are potential forerunners of spalled areas, particularly if the cracks are directly over reinforcing steel as described above.

The spalled areas, polished aggregate areas and the hair line cracks were not solely confined to the larger bridges on the Turnpike such as the Passaic and Hackensack River Bridges but were found in many of the smaller bridges which carry the New Jersey Turnpike over streams, railroads and other roads.

Originally the Turnpike Maintenance Department filled the spalled areas with bituminous cold patch material which was purchased from local mixing plants. This material was installed rapidly and at very little cost; however, it lasted only a few days, a week at the most due to the heavy and fast moving traffic. While the material costs were low, the traffic protection costs were high. The inconvenience to the traveling public had to be considered as the closing of just one lane forced three lanes of traffic into two or even one lane. The average daily traffic for the year ending August 31, 1958, was 112,300

vehicles while the average daily traffic for the year ending August 31, 1959, was 125,000 vehicles. The daily average for the month of August 1959, was 146,000 vehicles.

A material which could be installed rapidly and one that would last practically indefinitely or as long as the structure itself, had to be found. The Maintenance Department experimented with several materials that the manufacturers claimed would answer our requirements. Finally two manufacturers producing similar products provided the material that best suited our needs. One material was an epoxy patching compound consisting of a two component epoxy resin with the aggregate to be added by the user. The second product consisted of a two component epoxy resin with aggregate and emery particles which provided a suitable dressing for anti-skid protection.

The first step in repairing spalled areas was to remove all loose particles of concrete by means of a small chipping hammer. The chipping hammer may be operated by either air or electricity. On the New Jersey Turnpike, the electrically operated hammer was used exclusively because each of the seven Maintenance Districts is equipped with a portable electric generator. After the surface of the spalled area was clean, sound and dry, the filling operation was started. The second step was to blend the two components of the epoxy resin by means of a small portable electric drill with wire paddles. It was essential that the entire contents of both containers be completely mixed until they are a uniform light gray color. The surface to be patched must be primed with the mixture by means of a paint brush. To the balance of the mixture was added dry, manufactured sharp stone sand or silica sand. The electric drill was used again to blend the mixture and the sand aggregate. The mixing was continued until the drill and paddle were practically stalled by the mixture. The correct amount of sand had been added at this time. The mixture was then placed in the spalled area and troweled to a smooth surface finish. While the mixture was still tacky, sharp sand or emery particles were spread lightly over the completed surface of the patch. The sand or emery was troweled into the epoxy resin while in the tacky condition to give the non-skid quality desired. The completed patches are a shade lighter than an average concrete slab, however, after a short time are quite unnoticeable.

It is essential that the mixture be used immediately particularly if the air temperature is above 70 degrees. It is advisable to keep the containers of the epoxy resin in the shade or in cold water prior to their use in order to retard the action of the compounds. The epoxy patching compound when thoroughly mixed, has a pot life of no more than thirty minutes at seventy degrees. For best results, traffic is kept off the patched area for about four hours.

The second product is used in the same manner as the one described above with the exception that the manufacturer has provided the aggregate in addition to the epoxy resin material. Preparation of spalled areas, mixing and placing are similar for both products. The first product provides about two thirds of a cubic foot of mixture while the latter provides about one half of a cubic foot of mixture. Both products are unharmed by freezing temperatures before or after use, are quick setting, waterproof, abrasion and chemical resistant. Both products may be "feather edged" and will bond to any reasonably clean and sound surface, free of oil or grease.

On the basis of successful experimentation of epoxy resins for patching spalled areas in concrete deck slabs in 1958, a contract was negotiated with a Contractor by the New Jersey Turnpike Authority to patch the concrete deck of a viaduct on the Newark Bay-Hudson County Extension. The work was completed during the summer of 1959. Approximately 3,300 square feet of patching was installed at a total cost of $26,000 or about $8.00 per square foot. Because of the varied depths of the patched areas, a cost per cubic foot is not readily computed. The cost of $8.00 per square foot includes labor, insurance, welfare and pension funds, materials, flagmen, tolls, performance bond, overhead and profit.

The patching of spalled areas in concrete slabs by Maintenance Department personnel is scheduled for three days a week namely, Tuesday, Wednesday and Thursday during May, September and October. Four Maintenance Men and a Senior Maintenance Man are assigned to the work, supplied two dump trucks, signs, traffic cones, materials and miscellaneous tools. As soon as the traffic protective devices have been erected, one man is assigned to cut out all loose concrete with the chipping hammer, one man to clean out the spalled areas, one man to mix the epoxy resin and one man to place the mixed material in the area to be patched. The fifth man acts as flagman to signal traffic away from the work area.

The four man crew accomplishes this type of patch work from 8 a.m. to 1 p.m. From 1 p.m. to 4 p.m., the same crew carries on other maintenance work in the area, such as, grass cutting, joint filling, bridge

● **SPALLED** area to be patched is filled and surface is trowled smooth. Sand or emery are sprinkled on tacky surface.

Photos courtesy Sika Chemical Corp.

● **ALL EQUIPMENT** needed for mixing and applying the patch materials can be seen in this picture. Crew totals five.

● **STEEL flanges had slippery surface even after beads were welded on, as in foreground. Epoxy-bonded sharp stone sand has skid-proofed other lane.**

sweeping, guard rail painting, etc. This provides the epoxy resin mixture with a minimum curing period of three hours. Advance cutting of concrete is not attempted because of the possible hazard to traffic; however, cut areas not filled with epoxy resin are temporarily filled with cold patch. From 4 p.m. to 4:30 p.m., traffic protective devices are removed and the lane or lanes reopened to traffic. The flagman remains at his post until the road is fully reopened to Turnpike traffic. The patching crew will complete from 15 to 20 patches per day at a cost of about $150. This cost includes labor, traffic protection and materials but does not include equipment rental of Turnpike owned vehicles, tools, etc. No attempt has been made by the Maintenance Department to date to keep track of the areas patched each day, therefore, it is not possible to compare Contract costs with Maintenance costs.

A great many spalled areas approximately 1″ to 6″ wide, 12″ to 60″ long and as much as 4″ deep are found at the ends of concrete slabs, that is at the expansion joints. In the past, it has been difficult to hold patches at these locations because of the action of traffic. On the Turnpike, the spalled area was cleaned of loose particles, a small wooden form set firmly against the edge of the expansion joint and epoxy resin compound installed. To date the repairs by the Maintenance Department at the joints have been successful.

The epoxy surface compounds are used to reinforce the existing polished surface of the concrete deck. The two compounds are mixed by the portable electric drill with paddles and then spread over the concrete without the addition of aggregate. In locations where the concrete surface is extremely rough, aggregate such as sharp sand or emery particles or both, may be mixed into the compounds as described above for spalled areas. As in the case of the spalled areas, the surface to receive this material must be clean and solid. The coating is spread with a trowel, brush or squeegee depending upon the thickness desired. Sharp sand or emery particles are spread lightly over the surface to provide a non-skid surface.

The epoxy crack sealer is used for sealing cracks in horizontal concrete surfaces. The two components of the epoxy resin are blended and then allowed to run slowly into the crack which has been cleaned of dust, chipped particles or other foreign matter. Traffic is allowed on the completed work after four hours when the air temperature is seventy degrees or better.

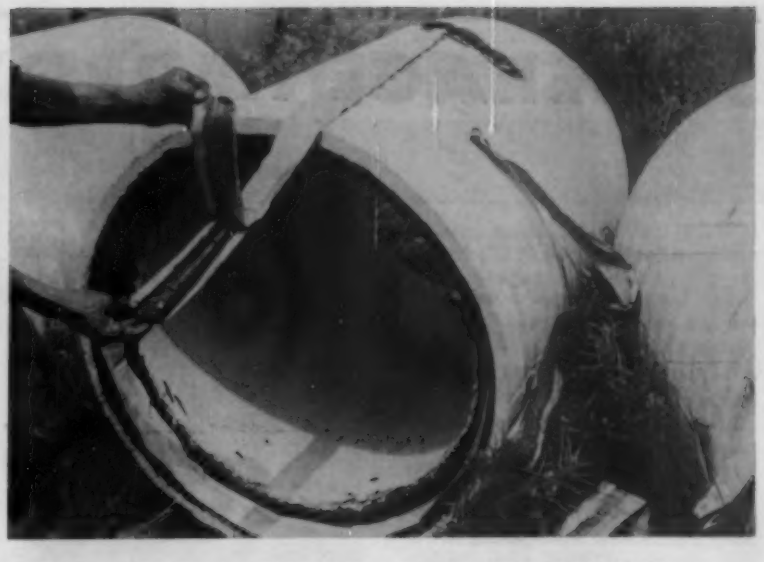
In addition to the uses described above for spalled areas, polished areas and cracks, the Turnpike Maintenance Department has developed other uses for the epoxy resin and the sharp manufactured stone sand. These uses may or may not be confined to the New Jersey Turnpike. The first use was to eliminate slippery conditions on wide flange steel expansion dams, especially those installed on super elevated ramp pavements. The east bound ramp from the Bayonne Interchange, No. 14A, on the Newark Bay - Hudson County Extension, contains several skew expansion dams. Trucks with dual wheels traveling up the grade have experienced axle trouble because one set of dual wheels was on the concrete deck while the other set of dual wheels, same axle, was on the slippery wide flange of the steel expansion dam. An attempt was made in 1958 to weld 45° angle beads on the flanges to improve traction but this did not prove successful. During the summer of 1959, epoxy resin mixture less aggregate was applied to the steel flanges of the expansion joints. While the epoxy resin was still tacky, sharp stone sand was spread lightly on the mixture to provide a skid resistant surface. This type of surface treatment proved to be successful.

The second use was undertaken inside of a second floor room of a New Jersey Turnpike Authority Service Area which houses air conditioning equipment. During hot humid weather, moisture formed on parts of this equipment which could not be wrapped with insulation material to prevent warm air from coming into contact with cold piping or valves. The moisture ran into cracks formed by the floor and walls of the room and eventually onto the lower walls of the restaurant and gift shop. The paint on these walls was damaged by the moisture.

In order to alleviate this condition, epoxy resin compound was first troweled onto the intersections of floor and walls to form a small triangle which prevented the moisture from seeping through. Then, two one-brick high walls were installed inside the equipment room to form a trough for the moisture. Epoxy resin compound was troweled against the floor and brick as a waterproofing material. This waterproof trough led the moisture to a floor drain. The completed installation was successful as the lower walls dried, were repaired and repainted.

Epoxy resin will be used on the concrete steps from the platform level to the basement of the Service Area Buildings in the immediate future. This use will be in conjunction with the installation of abrasive step nosings. The nosings, when installed, will be approximately ⅛″ higher than the concrete tread. The epoxy resin compound will be placed in the space between the back of the nosing and the base of the concrete riser. Sharp stone sand or emery particles will be spread lightly on the epoxy resin compound while still tacky in order to form a non skid surface.

The use of epoxy resin compounds on the New Jersey Turnpike will result in longer life for the concrete bridge decks and other concrete areas and in lower maintenance costs for the overall bridge structures, Service Areas and Interchanges. It is now possible to patch a spalled area and to expect the patch to last as long as the structure. It is also practical to use epoxy resins for varied uses as described above with success without resorting to expensive labor, equipment, tools and materials.



● PLASTIC rope is used for jointing sewer pipe. Protective paper is peeled off one side and rope placed in bell, as shown. Rest of paper is removed as the joint is about to be made in the trench.

DIFFICULT SEWER JOINTING PROBLEM SOLVED WITH PLASTIC PACKING

GEORGE A. SMITH
City Engineer,
Pasadena, Texas

PASADENA, Texas, one of the fast growing Gulf Coast cities with an estimated population of 62,000, has a widely varying soils structure including gumbo, water bearing sand, joint clay and hard red clay. This means shifting conditions and infiltration problems. We have been in constant search for a joint sealing compound that will remain permanently flexible, will be easy to install and to inspect and will prevent infiltration, especially in our deep sub-aqueous sanitary sewer mains.

Recently we used a plastic rope joint material, known as Ram-Nek, on three major installations: a 30-in. tongue and groove sanitary sewer approximately 16 feet deep; a 12-in. bell and spigot sanitary sewer low pressure main; and a 30-in. tongue and groove concrete pipe storm sewer. On the 30-in. tongue and groove sub-aqueous sanitary sewer we had the contractor apply one coat of primer to the pipe joint surfaces before attaching the plastic rope joint material to the groove end of the pipe while still on the bank. Ram-Nek is furnished in any length or size desired and is protected on both sides with tough paper strips. The protective paper strips on one side are removed and the rope is attached to the groove or bell end of the pipe. On this particular job we wanted to be sure of tight joints; therefore, another plastic rope was placed around the tongue end of the pipe. The pipe sections were lowered into the trench after the trench was graded to proper elevation. The protective paper strips were then removed exposing clean joint surfaces and each tongue end was shoved into place by the crew using a bar as a wedge while the pipe was being lowered and just before final seating.

It rained a great deal during the installation. Each night the end was blocked with a plug, using this same plastic rope compound and on numerous occasions as much as 16 feet of water would stand for days over this line, where trenches were only partially backfilled. We believe we have a very water-tight sewer main at a reasonable cost, and we are convinced that the method of preparing the joint at the job site encourages accuracy in jointing technique.

On the bell and spigot, 12-in. low pressure sanitary main we used jute caulked into the bell as a filler and to withstand pressures.

We are seriously considering making the use of Ram-Nek mandatory in all our sanitary and storm sewers.

● HEAVY rains during construction of line kept water in trench and permitted on-the-job test of tightness of joints.

● JOINT material may be seen in groove end of pipe. Paper strips are peeled off before joint is completed.

SEWERAGE IMPROVEMENTS

KENDALL H. LEE,
City Manager,
Asbury Park, New Jersey

A FEW MONTHS ago the Asbury Park Development Committee adopted a slogan "come see the new Asbury Park". This is not an empty, meaningless phrase, but rather an expression of the changes that have taken place in the city during the past two years. This past May Asbury Park's new intercepting sewer was completed. This major public improvement, constructed by the Verona Construction Company of Verona, New Jersey, replaced a sewer that was more than fifty years old. It was the consensus of opinion that the old sewer was outmoded and inadequate to meet the needs of a rapidly growing community. As a matter of fact more than five years prior to the date the new sewer was started, the City Health Department, competent engineers and the State Department of Health recommended that a new facility be installed.

About two years ago the Mayor and the Council authorized the City Manager to proceed with all possible speed in the construction of this sewer as the most needed public improvement, and then to proceed forthwith on major improvements to the sewage treatment plant. An application was made and approved by the Housing and Home Finance Agency for a loan, non-interest bearing, to cover the cost of sewer plans and specifications. The firm of Fridy, Gauker, Truscott & Fridy, Engineers, was engaged to prepare the necessary plans and specifications. In September, 1958, bids were received ranging from $387,000 to $579,000. In October the contract was awarded to the low bidder. The working schedule projected by the contractor called for the construction to commence on or about December 1, 1958. The sewer was actually finished in May, 1959. The exact completion cost has not yet been determined but it is estimated it will be approximately $475,000, including engineering fees.

In connection with the preliminary survey and preparation of plans and specifications for the improvements to the sewage treatment plant the City did not borrow the planning funds from the Housing and Home Finance Agency, but instead provided its own temporary financing. In January, 1959, bids were received for alterations and improvements to the sewage treatment plant. Lowest bidder was the Thomas Proctor Company with $610,000. It is estimated that engineering costs, including resident supervision, and legal costs will increase the total to somewhere in the neighborhood of $670,000. This brings the total improvement costs to a figure in excess of $1,150,000. Complete plans and specifications developed by the engineers on both the projects were also submitted with an application for a Federal grant.

In order to clarify the many phases of operation involved in the construction of the intercepting sewer and the sewage treatment improvements, each of these projects will be treated separately in this article.

Intercepting Sewer

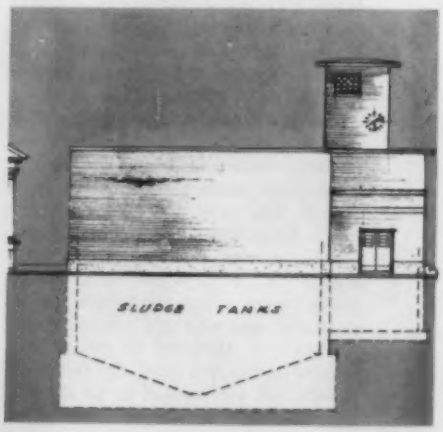
The report and survey completed by Fridy, Gauker, Truscott & Fridy shows that Asbury Park has for many years been served by a system of separate sanitary sewers, which collect and conduct the sewage by gravity through north and south intercepting trunk sewers to the primary sewage treatment plant, located along the beachfront at Eighth Avenue, between Ocean Avenue and the boardwalk. After treatment, the sewage is discharged to the ocean through an 18-inch ocean outfall sewer, extending more than 1,000 feet off shore.

The old south intercepting trunk sewer, for many years has been giving considerable trouble with sluggish flow, clogging, overflowing and failure, resulting in the need for periodic temporary pumping, partial reconstruction and extensive maintenance costs.

A preliminary engineering investigation was made of the condition of the south intercepting sewer and its collecting branches during the winter of 1956. The study revealed that the sewer was constructed with very flat grades, permitting accumulation of sand and solids during low flow periods. In one instance the grade between manholes was practically flat and in another location the grade was against direction of flow. In most cases, grades are below that required to produce self-cleaning velocities, and accordingly are below state requirements.

In the area between Prospect Avenue and Bond Street, sewage was found standing to a depth in excess of two feet, creating septic conditions and producing odors. Furthermore the size of the trunk sewer was found inadequate in several stretches to handle current loadings with infiltration.

It was recommended by the engineers that the unsatisfactory condition be corrected by the complete reconstruction of this intercepting sewer from Borden and Springwood Avenue to the treatment plant. This recommendation included the use of larger size pipe, that of a smoother internal finish permitting better flow and velocities to assist in self cleaning and the relocation of the southwest - northeast section to Kingsley Street as it was believed that more stable bearing conditions would be encountered further inland. By this plan the sewer system would be retained on a completely



● **ELEVATION of sewage treatment plant at Asbury Park, N. J. This installation is at a beach-front location between a band pavilion at left and the Municipal Building at the right.**

PROTECT BEACH RESORT

● PIPE FOR new sewer system is shown in storage along street as power shovel opens trench. Note well-point system installation to permit work in dry trench.

gravity basis; infiltration would be substantially reduced; adequate carrying capacity would be provided; and ponding in the sewers eliminated.

Statistical Study

To establish the size of the proposed new intercepting sewer, a house count and water consumption study was conducted in the areas of the city contributing to the inflow of the south intercepting sewer. The house count has made a matter of record the number and type of buildings served by the respective collecting sewers which discharge at the various points to be intercepted by the proposed sewer. Due to the great and variable influx in population during the summer months, a population basis of flow estimates, with normal per capita daily allowance, was considered to be inappropriate. Accordingly, water consumption records for the properties to be served by the proposed intercepting sewer were compiled, totalized and studied to establish the current flow to the respective sewers.

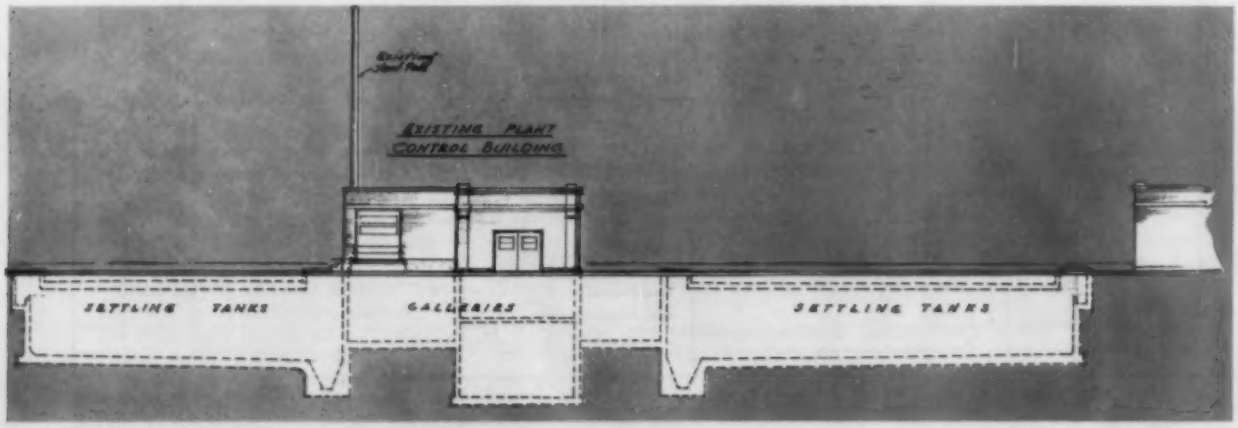
Based on the foregoing investigations and survey, a new south intercepting sewer was designed, with capacity established on the estimated 1983 water consumption, in area to be served, plus an allowance for overall system infiltration.

The sewer is of Johns-Manville asbestos-cement. It starts as a 16-in. on Springwood at Borden Avenue and extends eastwardly along Springwood to Sylvan Avenue. Here the size is increased to 18 inches along Springwood to Main Street. A 20-in. sewer is used along Lake Avenue to Emory Street, where it becomes 24 in. and extends along Lake Avenue to Kingsley Street; thence north on Kingsley to Asbury Avenue where another increase occurs to 30 in. From here it follows north along Kingsley to Eighth Avenue, thence east along Eighth to Ocean Avenue and the treatment plant.

Sewage Treatment Plant

Principal among the assets of Asbury Park are the popular bathing beaches and adjacent recreational facilities. Their proximity to the municipal sewage treatment plant, located between Ocean Avenue and the boardwalk at the end of Eighth Avenue, makes it mandatory that the plant be not only ample in capacity but also of modern design with careful operation and maintenance. With the completion of current construction, which is the second and final stage of a program started several years ago, the sewage treatment facilities will be modern, of capacity suited to serve future population projections, and conforming to the requirements of the State Department of Health.

Many years ago, at the site of the present treatment plant, a sewage pumping station was constructed. This station received the raw sewage which, after coarse screening, was pumped through an outfall pipe into the ocean. Later this was augmented by the addition of a pair of underground septic tanks, to retain a substantial portion of the sewage



solids until after the bathing season, when they were pumped to sea in accordance with a policy adopted by the Department of Health in 1928.

In 1934 the nucleus of the present plant was designed and construction followed shortly thereafter. This design provided for the abandonment of the older pumping station and outfall sewer and its replacement with a larger pumping station, a larger ocean outfall sewer and supplemental underground primary settling and contact tanks. These expanded facilities provided raw sewage screening and pumping and plain sedimentation with disinfection of the settled sewage prior to discharge 1000 feet off shore of the low water line. The previously constructed septic tanks were converted to provide for the summer storage of the removed sludge, which was pumped to sea during each following winter.

The enlarged plant has a design capacity of 5.5 mgd average flow. It is estimated that the bulk of this daily flow reaches the plant during the 16-hour active portion of the day and there will be short duration peaks at rates nearly double that of the average daily flow, or 9.75 mgd. These flow estimates include an infiltration allowance of 1.25 mgd for ground water, with a 1973 estimated population of 42,500 people discharging a sewage flow of 4.25 mgd.

Description of Units

The 30-inch South Asbury intercepting sewer and the relocated 18-inch North Asbury sewer both discharge into a common manhole on Ocean Avenue in front of the sewage treatment plant. Chlorine solution, fed from two solution feed chlorinators, is applied to the raw sewage as pre-chlorination for odor control. From this manhole the sewage flows to a ventilated control manhole adjacent to rectangular grit chambers.

Sewage can be directed to either or both grit chambers through 24 by 36-in. hydraulic operated sluice gates. In case of emergency all or part of the sewage can be conducted around the grit chambers. Each grit chamber is 10 ft. wide by 14 ft. effective length, with a design flow depth of 0.42 ft. at a 1.0 fps velocity. Control is by a proportional weir at the outlet end. Sewage entering each chamber is distributed by aluminum alloy vanes across the width of the chamber, flows the length thereof and is collected at the effluent end through three proportional flow control weirs. Grit particles reaching the bottom roll to near the effluent end and through perforated plates into grit hoppers with steep side slopes. Grit is removed from the hoppers by air lifts and conducted through separator pipes to grit cans. Putrescible material overflows the rim of the grit cans and washed grit settles to the bottom. The cans are removed by the existing screening hoist for disposal.

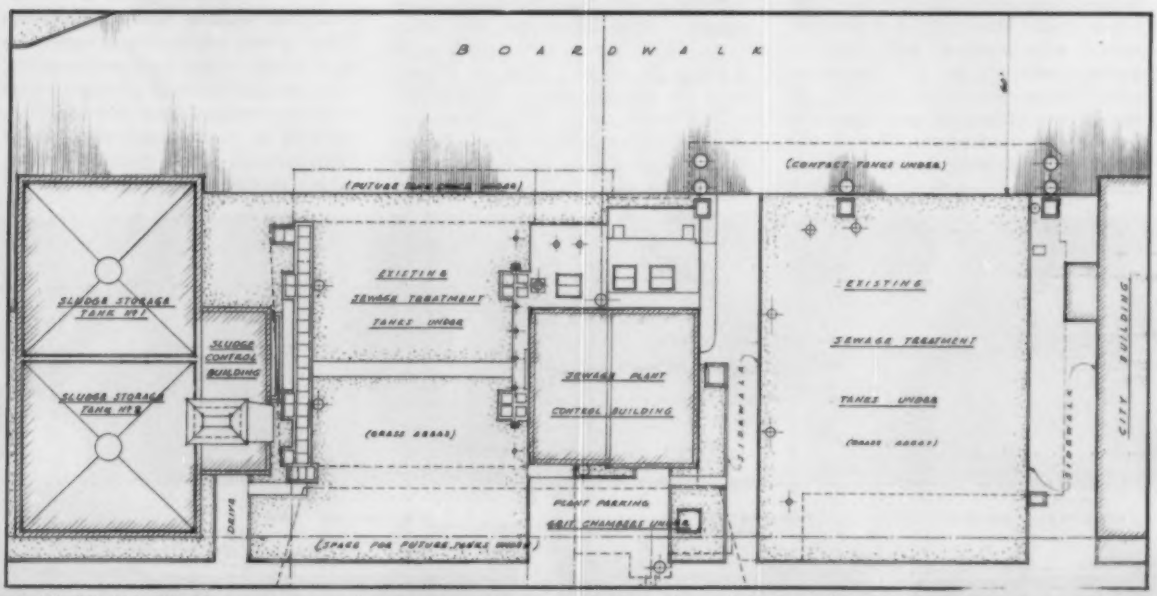
Sewage leaving the grit chambers is screened and shredded by one of two Chicago "Barminutors." Each unit has a capacity range of 0.34 to 6.5 mgd. The emergency overflow channel adapted from the existing plant influent channel and gate is provided with a manual bar screen for emergency removal of trash which can be disposed of ahead of the Barminutors, when in service. Screened sewage is then conducted to the two sub-surface, circular pump suction wells through channels, modified to suit new entrance conditions.

The original raw sewage pump No. 1 was replaced by a new large capacity pump, No. 5, and the old unit was relocated to serve as an emergency building flood pump. Under the present work the No. 2, No. 3 and No. 4 pumps are being replaced with units rated at 900, 1,200 and 1,500 gpm, respectively.

Pump No. 5 is presently in service with a 3,400 gpm impeller, but it can be increased in capacity to 5,000 gpm upon installation of spare impeller, already in stock.

The four raw sewage pump discharges are collected into a common cast-iron pipe header leading to a 20 x 14-in. venturi tube, with a Simplex indicating, totalizing and recording meter. After measurement the screened sewage is conducted through a 20 to 12-inch force main to the primary settling tanks. An alternate take-off would permit discharge to the ocean during winter months.

Eight rectangular, covered primary settling tanks are provided, with four flanking each side of the



● **SINCE ALL UNITS are constructed underground or are attractively housed, few visitors would realize that a sewage treatment plant is located between the Boardwalk and Ocean Avenue. Ocean outfall sewer extends underneath the Boardwalk.**

central pumping and control building and north and south galleries respectively. Those on the south are original and have a total capacity of 378,000 gallons. Those on the north are of recent construction and have a capacity of 302,400 gallons. The total capacity of 680,000 gallons for all tanks provide a 3-hour detention period at the design average sewage flow rate. All tanks are equipped with Link Belt sludge and scum collectors. Sludge is withdrawn hydrostatically through 8-inch cast-iron withdrawal pipes and scum is mechanically wiped into scum troughs and conducted to scum chambers.

The settled sewage from all tanks is collected by a system of piping and discharged to concrete contact tanks where chlorine solution is applied for disinfection of the sewage. The chlorine from either or both of the 2,000-pound per 24-hour Wallace and Tiernan chlorinators is applied at the inlet ends of two adjacent chambers or tanks, one of which serves the north group of settling tanks while the other serves the south group. These tanks can be used independently, or collectively. Further contact period is provided for the discharge of these tanks by a serpentine, baffled tank or series of channels to provide in all 113,500 gallons capacity or equivalent detention period of 30 minutes at design flow rates.

Chlorinated, settled sewage can flow by gravity, during periods of low tide, through the 18-inch ocean outfall sewer extending more than 1,000 feet off shore, beyond the low water line. When tides will not permit gravity flow the sewage is pumped automatically by a combination of three Fairbanks, Morse effluent pumps. Two of these units are horizontal pumps, each with a capacity of up to 3,000 gpm, while the third is a vertical unit with 3,400 tpm capacity. Pumps operate in selected sequence dependent upon the flow. Except during low sewage flow and relatively low tidal conditions when gravity flow is possible, the outfall sewer is used as a pressure force main.

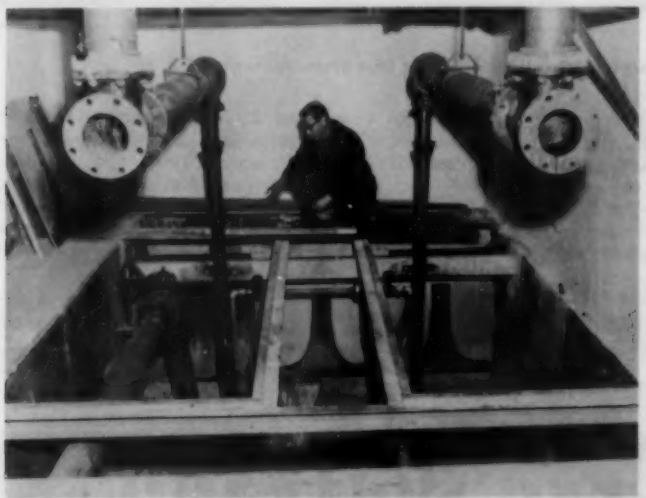
Sludge from the individual sludge hoppers at the influent end of each settling tank is withdrawn hydrostatically and conducted to any or all of four Marlow sludge transfer pumps. Similarly scum and floating matter accumulated in three scum chambers is conducted to the same pumps. These pumps can deliver the sludge and/or scum to the new sludge digestion and storage tanks, located at the northern end of the treatment plant site. With the same piping array the settling tanks can be dewatered for maintenance or seasonal shut-down purposes or the sludge and/or scum can be discharged into the ocean during the winter months.

Another sludge pump located in the basement of the digester operating building provides means of transferring sludge between the digestion tanks, to recirculate it to other tanks or to discharge digested sludge to the ocean during the winter.

Replacing the inadequate and dangerous old sludge storage tanks beneath Ocean Avenue, are two new sludge digestion tanks of modern design and are equipped by Pacific Flush Tank Co. Each is 43 feet square with a side water depth of 31.5 feet and a 9 foot conical hopper and has a mean water depth of 34.5 feet affording a total volume of 127,581 cubic feet. This volume provides capacity for 3 cubic feet per capita, based on 1973 estimated population of 42,500 persons.

Both tanks are equipped with square floating covers of modern design with access manholes, sampling wells, gas dome, pressure and vacuum relief, ventilators and drain pumps. One unit is equipped with the Pearth gas recirculation system. Internally the tanks are equipped with supernatant drawoff screens, gas withdrawal mains, sludge drawoff, supply and recirculation pump, cover position indicators, temperature recorders and plunger transfer pump. This equipment is arranged to permit use of either tank for primary heated digestion, and the other for secondary digestion and sludge storage. Digested sludge could be loaded on a tank truck for use as liquid fertilizer, or pumped to the ocean, during the winter for disposal. Supernatant liquor and drainage can be returned to the raw sewage inlet via the North Asbury sewer. Sludge gas, generated in the tanks is separately metered, and utilized for heating of the sludge and buildings. Waste gas is metered and burned in a waste gas burner so located to be screened from view by a masonry tower with open top, fire brick lining and external ornamental clocks. City gas is provided as auxiliary fuel. It is anticipated that one tank will be main-

(*Continued on page* 205)



● **SEWAGE treatment plant under construction. Grit chamber is in background. Note proportioning weirs to control flow in grit chambers.**

● **ELECTRICAL panel provides control and operation for entire plant, including automatic pumps.**

PRINCIPLES OF SOIL ENGINEERING

ROBERT F. BAKER, Professor of Civil Engineering, The Ohio State University

IN UNDERSTANDING a problem concerned with the engineering behavior of soils, one must know which one or more of the three basic types of considerations are involved; i.e., stability (shear), settlement, or permeability. Part of the confusion in dealing with soils is that the problem is not reduced to this type of simplicity. Even though such a basic simplification of the problem will assist greatly in a logical approach to the solution, the detailed considerations that remain are relatively complicated. However, the details of the complex problem can be left mainly to the specialist.

Actually, a soils study is not too dissimilar from any other engineering problem. The load is specified or is to be measured, the stresses reaching the soils must be determined and the reaction of the soil to those stresses must be computed. A notable difference is that the materials of a non-soil structure are selected by the engineer, whereas with soils, one normally makes use of the material nearby or in-place. Thus, a problem not encountered in the super-structure but present in the foundations is the determination of *what* is present and *how* it will behave.

In the following discussion of design problems, the following main sub-divisions have been made: (1) Investigation; (2) analyses; and (3) special problems.

Part II—DESIGN CONSIDERATIONS

INVESTIGATION

The collection of data that are pertinent to the problem include both field and laboratory investigations. These studies answer the questions: (1) What material is present?; (2) How much of it is there?; (3) In what condition is it?; and (4) How will it react to stress?

The field studies are principally concerned with the first two questions, but field tests may aid in an estimate of the last two, also. Laboratory tests can clarify the first two questions, and frequently furnish most of the information on the last two.

Field Investigation

Soil studies always require basic data relative to the elevation and plan view of the ground surface. If not provided, it will have to be obtained in some form by field crews before any interpretation is possible. Data from the field include descriptions of strata encountered, disturbed and undisturbed samples, depths to the samples, and the location of the water table.

The most important part of the field studies is the sub-surface work. In planning for the field work, knowledge of geology aids in keeping the work to a minimum and in the interpretation of the data. The role of geology lies in the understanding of how nature works in developing soil strata as well as surface configurations. Furthermore, published geologic descriptions as to earlier studies in the area give advance information as to what to expect in a general way.

In planning the work advance studies of the geology will aid materially. Initial sub-surface work is planned on the basis of the advance knowledge relative to both geology and the type of structure under design, and upon a preliminary surface reconnaissance. A large-scale field study should be planned only after preliminary sub-surface work has described how uniform (or non-uniform) the conditions are, and has located the soil strata most likely to give serious trouble. Following this first approximation more detailed exploration can be established. (This procedure avoids arbitrary spacing as a standard for large-scale studies, which could lead to over-drilling, to drilling in the wrong locations, or to collection of too many samples. The procedure for planning the final sub-surface work from the results of the preliminary studies comes with experience and is largely a question of collecting more data in the troublesome strata.

Equipment for Sub-Surface Studies

Three principal types of equipment are utilized in sub-surface explorations: core drills, auger drills and geophysical instruments. The

first two have become quite common. Standard core drills that have been utilized for structural foundation studies for years generally drive a steel tube (termed a casing) through the soil to bed rock or to the elevation desired as shown in Figure 15. The interior of the casing is cleaned by washing. To drill through rock, a hollow steel rod with a diamond or hard metal bit attached to the end is lowered into the pipe. Water to cool the bit and to remove the cuttings is fed through the rod.

Auger drilling is simpler and less expensive, but generally provides less certain data. Continuous helical rod or a post-hole bit arrangement are utilized. Samples are collected at the ground surface, and the depth to changes in soil strata are inferred. A somewhat more costly alternate to estimating the changes consists of removing the auger to obtain a sample at the depth drilled. Augers are of little help in a saturated sand since a casing is not normally used and the hole caves in too rapidly.

Geophysical methods conducted on the ground surface consist of electrical resistivity or seismic techniques. The latter may be more reliable, but in the hands of a competent person, electrical resistivity can provide good information at less cost. Electrical resistivity identifies soil strata on the basis that a change of soil type will change the resistance to flow of an electric current. On the other hand, seismic methods rely on the time that it takes for a shock wave to travel from the ground surface to a strata and to be reflected back to the surface. Obviously, samples of the soil can not be obtained, and nothing but descriptive data are obtained with any reliability.

Sampling of the soil can be either disturbed or undisturbed in type. In the former, the soil is identified as to location and stored in a container with no effort being made to retain the structure or moisture content. Such samples are utilized only for classification purposes. Undisturbed samples are obtained by various types of special sampling "spoons" which have been designed to obtain samples with the least possible disturbance. No truly "undisturbed" sample can be obtained. Even the relaxation of pressure produced by removing the material above it changes the structure of the soil. Furthermore, forcing metal through the soil disturbs the immediate surroundings. Such problems merely emphasize and do not change the fact that all care possible should be taken in obtaining such samples, in preparing them for shipment, and during the shipment. Vibrations and impact during transit can destroy the usefulness of a sample.

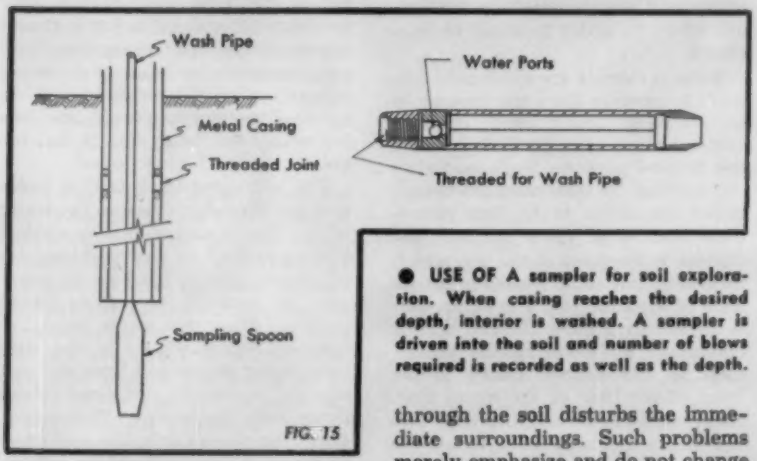


FIG. 15

● **USE OF A sampler for soil exploration. When casing reaches the desired depth, interior is washed. A sampler is driven into the soil and number of blows required is recorded as well as the depth.**

The location of the water table is almost inevitably of interest in a soil engineering problem. Drillers and inspectors conventionally note when free water is encountered. In clay soils, however, low permeability may mean that several hours are required for water to rise in the drill hole to the level of the water table.

The implications produced by artesian effects are also of interest. If a clean sand underlays a tight clay, water may rise quite rapidly in the casing, indicating the presence of so-called artesian pressures. The actual water table may not be discernible because the water will rise to the level produced by the artesian pressure. Since artesian effects can vary and since upward flow of water through the clay will not be rapid, the drill hole must stop short of the sand layer in order to determine the water level in the clay.

All three of the previously mentioned types of sub-surface equipment are currently in use. Due to the inherent advantages to each, many groups are equipped with all three and utilize them so as to achieve maximum efficiency and minimum cost. Repeated references to investigation costs represent the writer's concern that a general tendency toward more drilling and testing than is necessary unduly increases the cost of soil studies.

Field Identification

In all field work, soils are tentatively identified at the site. This preliminary identification is not too critical except that a good observer can reduce the number of samples taken. The basis for the field classification is essentially the same as is used in the laboratory. Observation can establish the presence of sand and gravel. The presence of fines usually leads to such designations as silty-sand if the sand predominates; or sandy-silt if the latter is present in larger percentages. Exactness as to designation is not so critical as consistent identification. The color of the soil is also recorded for future aid in locating strata boundaries.

Silts and clays are separated from very fine sands by their plasticity. Rolling a thread between the hands produces evidence of (or lack of) plasticity. The soil can be moistened if too dry to be plastic. In determining the difference between silt and clay, a ball of the wet soil is permitted to dry. If the material is then hard to pulverize it is clay; if it crumbles readily, it is mostly silt.

An important item in field identification is the spotting of organic materials. These materials are generally dark gray, blue to black in color. Roots and other pieces of organic matter can sometimes be seen. A foul odor will also be evident if the soil is very organic.

Field Testing

Most field work in soils engineering is concerned with determining "what" is present, rather than attempting to evaluate strength properties. Other than simple classification tests, it is rarely feasible to attempt to test further until there is some understanding as to how much of a given material is present, and how uniform the strata actually are. Therefore, interpretation of the preliminary subsurface data is needed prior to the start of the field testing program.

Excluding the simple classification type, not all soil studies require field tests. The decision is usually based upon (a) type of analysis

planned, (b) the extent of the laboratory equipment available, and (c) the type of material encountered. The influence of the type of analysis is one of economics and of the feasibility of a comprehensive, accurate analytical approach. Field testing can be expensive and the results may not justify the cost, particularly with reference to the value of the structure and the reliability of estimates without field tests.

Of the several types of field tests commonly incorporated with investigation, the following are most frequently used: (a) unit weight and moisture content; (b) standard penetration resistance; (c) vane shear; and (d) permeability. Field tests used for construction control and bearing capacity are discussed in subsequent pages. Unit weight and moisture content are much more often completed in the laboratory than in the field but some engineers prefer to have such work done at the site. The unit weight test usually consists of obtaining an undisturbed sample in a metal tube of a known diameter or volume. By weighing and subtracting the weight of this tube the unit weight can be obtained by w/v which is equation (1). The moisture content is measured by drying a known weight of the natural sample, determining the weight of water by subtracting the final weight from the initial weight, and utilizing equation (2) assuming that the final weight is the weight of soil ($w\ \% = W_w/W_s \times 100$).

The standard penetration test is the one exception to the generality that field tests are not conducted during the preliminary phases of the sub-surface work. Frequently, the data are relatively easy to accumulate at the time, and are often beneficial in identifying a given soil strata. The test has been given preliminary procedure status by ASTM and consists of driving a sampling spoon of specific dimensions (see Figure 15) with 18 blows of a 140 lb. hammer falling a distance of 30 inches. The test is conducted inside the metal casing at a specified depth below the surface or at stated intervals.

Since the casing is cleaned out regularly, the test is conducted on soil just below the depth to which the casing has been driven. Assuming that the soil is relatively "undisturbed" at this level, a measure of the firmness of the soil in place is available. The results are expressed in terms of "blows per foot," i.e. a value of 6 means that 6 blows of the hammer were required to drive the spoon a distance of one foot into the undisturbed soil at the depth in question. Empirical relationships are available for converting the blows per foot into strength properties.

In the case of the standard penetration test certain cautionary words are in order. First, the results are quite sensitive to such factors as diameter and wall thickness of the tube, weight of the hammer, and the distance through which the hammer falls. Some organizations use a different test in terms of these factors, and have their own particular set of factors for conversion to strength properties. Therefore, one must examine and specify carefully the test procedure in order to avoid serious errors.

Some materials are extremely difficult to remove from the ground in a relatively undisturbed manner, particularly if they lie 25 feet below the ground surface. Such materials are typified by saturated fine sands below the water table. One procedure that is of value in such instances is the vane shear test which measures the total shearing resistance of equation (9). The equipment is shown in Figure 16. The test is conducted by lowering the equipment in the cleaned casing to the level at the base of the metal pipe. After carefully forcing the vane into the soil, a torque wrench twists the vane and the torque in inch-pounds or foot-pounds is recorded. Equations permit the conversion of the torque into shearing resistance in pounds per sq. in. or sq. ft. A laboratory test using miniature equipment has also been adapted from the field procedure.

Another condition that frequently requires a field test is the in-place permeability. Such tests are required where the quantity of flow through soil strata is an important factor such as the amount of leakage in dam foundation strata. Permeability, more than any other soil property, is drastically influenced by the structure of the soil. For one thing, small changes in structure can produce results that are as much as 1000 times the natural value, or are reduced in as drastic a manner. Therefore, the disturbances produced by sampling, transporting, and laboratory preparation reduce the reliability of the results. Also, the continuity of strata can be explored by field tests; i.e. avoid the mistake of assuming that a "pocket" is a continuous layer. In fact, where the in-place permeability is in question, there is no truly reliable way to obtain flow data, but the closest approximation may come from field methods in many cases. If there are exceptions to this, they would be for fine grained, impermeable soils for which the total flow is not too great.

The test consists of drilling holes to a specified depth below the water table. The actual depth is critical and controlled by the problem; i.e. whether a specific layer or the average of several layers is being studied. After the water level has achieved equilibrium in the drill hole, water is pumped from the casing. As a result, additional water flows into the casing. The procedures for obtaining k, the coefficient of permeability vary widely, but are all based upon Darcy's law as follows:

$$v = ki \quad \ldots\ldots \quad (12)$$

where:

- v = velocity in ft. per sec.
- i = hydraulic gradient, dimensionless
  - $= h/l$ = head loss in ft./length of flow in ft.
- k = coefficient of permeability in ft. per sec.

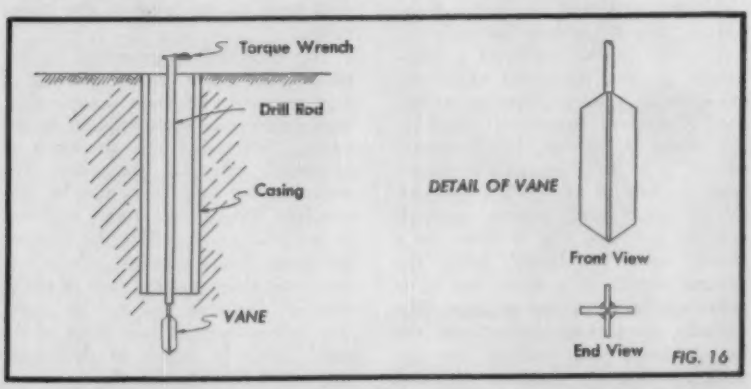


FIG. 16

● IN THE vane shear test, the vane is driven into the soil and the torque required to twist the vane is recorded. Torque is correlated to soil shear strength.

$$Q = Akit \ldots\ldots \quad (13)$$

where:

Q = Flow in cu. ft.
A = Area through which flow occurs in sq. ft.
t = time in sec.

In the field, use is commonly made of observation wells drilled at stated intervals, distances, and spacings around the well point. Observations of the water level permit the measurement of changes in the water table which in turn permits evaluation of the hydraulic gradient.

In addition to these general field tests, some special ones, such as the conventional plate bearing test for bearing capacity, are closely associated with analytical considerations and will be discussed under "Analyses" and "Special Problems."

Laboratory Testing

The samples obtained from the field investigation are transmitted to the laboratory for further study. The sequence of tests should be that specified by the engineer responsible for the analysis. Some organizations have a regular series of tests that are conducted on all samples. Such a procedure can lead to overtesting unless restraint is exercised in specifying the "Standard" tests.

To begin with, most samples need to be classified, and so the liquid and plastic limits as well as the grain size are needed. However, a competent laboratory supervisor, using the record of the drilling can sometimes reduce the number of samples tested. It is normal and not necessarily a waste of money to take more samples than absolutely necessary. For the field studies one may or may not have a competent soils man as crew chief. Besides, the weather, troubles with the equipment, and other practical problems may mean that a satisfactory judgment in the field cannot be consistently maintained. Therefore, if a regular interval for sampling (such as three to five feet) is set up, there is a good chance that more samples than needed for testing are delivered to the laboratory.

Assuming then, that the laboratory supervisor or the engineer-in-charge minimizes the number of actual samples tested for classification purposes, the next step must be specified by the engineer responsible for the analysis. Soil testing is not "regular" in the same sense as is the testing for cement, asphalt, concrete, or steel. This stems from the fact that the analyses are not completely analytic, and less easily generalized in terms of test requirements. For example, in Table 3 there is a list of the possible methods of test that a laboratory might be called upon to conduct.

Table 3—List of Soil Tests Most Frequently Used

Test	*Remarks*
Mechanical Analysis (Sieve and Hydrometer)	Classification
Consistency Test (Liquid Limit, Plastic Limit, and Plasticity Index—P.I.)	Classification; also used empirically as an acceptance test.
Specific Gravity	Classification as well as in analyses related to compressibility, degree of saturation, and void ratio.
Moisture-Density (Proctor)	Construction control of earthwork.
In-Place Density and Moisture Content	Used in field to control earthwork and conducted as undisturbed samples to indicate field conditions.
Permeability	Computations of quantity of flow through earth materials.
Shear Tests (Tri-axial, Direct, Vane, Unconfined Compression, Torsion, and Stabilometer)	Computations of the shearing resistance—results valid only if laboratory sample condition is comparable to that for which computed stresses are compared. Stabilometer frequently used empirically.
Penetration Tests (Cone Penetrometer, CBR, Ring Shear)	Converted (normally by empiricism) to a value reflecting compressibility as well as shear.
Consolidation Test	For computations of total and rate of settlement. Condition of the laboratory sample must be comparable to field condition.
Plate Bearing Tests	Used to obtain allowable soil pressure —combined shear and compressibility test—should be conducted on soil at foundation elevation—valid only for soils relatively close (in depth) to plate.

In most cases, the *conditions* under which the tests are to be conducted are even more critical than *which* tests. For example, in the general sense of the word, there is no "standard" tri-axial shear procedure. Depending upon what analyses are to be conducted the rate of loading, the lateral pressure, and conditions of sample drainage at top and bottom are a function of what the conditions will be in the field. If one is considering an embankment over soft, saturated ground, the most critical period in terms of stability (not settlement) is during or immediately following construction before the water can drain away and the soil can be consolidated. In such cases, a "rapid" test is needed as compared to some cases of bridge abutment which might be built several months ahead of the superstructure.

In summary, then, the conditions for the test of strength properties must be specified as well as the type of test. It will be recalled that only two basic types of problems exist; i.e. stability (shear) and settlement. Some laboratory procedures, such as the California Bearing Ratio, attempt to include both considerations in one test procedure. Further explanation of their role will be covered in the sections on "Analyses" and "Special Problems."

ANALYSES

Throughout the discussion to this point, repeated references have been made to the fact that only three types of problems are of concern to the soils engineer; i.e. stability (shear), settlement, and permeability. There is reason for the continuous reminder—namely, this simplifi-

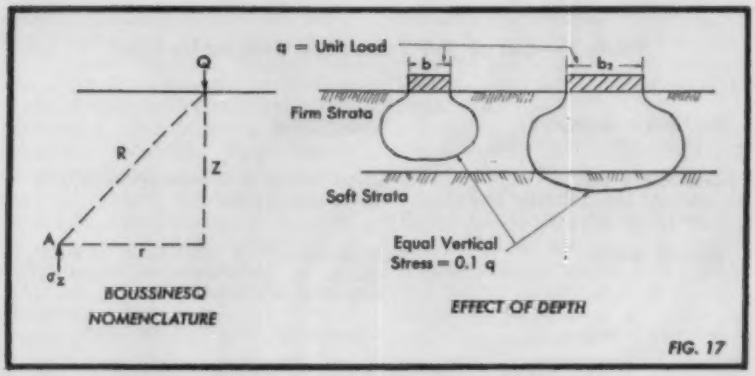


FIG. 17

● **BOUSSINESQ nomenclature used in Equation 14 is diagrammed at left. At right the effect of depth in foundation problems is illustrated. Note that while bulb of pressure for footing of diameter "b" lies entirely in firm strata, larger footing with same unit load produces an appreciable pressure in the underlying soft strata.**

cation above all others will clarify much of the mystery of soil engineering. Now, another generalization is of interest. Almost all soil problems are concerned with *foundations* or *slopes*.

For foundations, whether for a bridge, a building, a highway embankment, a dam, or a pavement, *the most serious problem is generally one of settlement*. Also, for slopes, including cuts, fills, and trenches, *the problem of stability (shear) is normally paramount*. Permeability, while affecting strength insofar as the location of the water table is concerned, is most frequently associated with problems of *losing or gaining water*, as exemplified by the question of water losses through or under an earth dam.

The preceding generalization on foundations and slopes must be qualified. For example, some foundation problems are as equally complicated by the stability question as they are by the one of settlement. Therefore, regardless of whether stability or settlement is most frequently controlling, both should be considered in the initial studies.

Settlement Problems

The studies of foundations include most of the important settlement problems and these are affected by the type of structure concerned; i.e., bridge, building, or embankment. However, the influences of the type of structure are more in the realm of the economical solution than they are in terms of analytical principles. First, the engineer must decide whether total settlement must be controlled. Second, the allowable differential settlement must be considered. Third, the rate of settlement is sometimes important, and four, the problem must be analyzed. For slopes, the only settlement question in addition to the one in the foundation is within the compacted mass of a man-made earth structure.

The term most frequently applied to structural foundation adequacy is "bearing capacity." This term is a most misunderstood and misused one. To many, it means only the allowable pressure which can be applied to the soil. The fact is, *bearing capacity implies a specific amount of settlement*. Not only that, but the value *varies with the size of the loaded area*. For example, the allowable *unit* bearing value on a two-foot square column foundation is actually *greater* than that permissible under a four-foot square foundation in order to get comparable settlement. Of course the *total* allowable load will be greater on the larger foundation.

Also included in the term allowable bearing value is the question of stability—will the structure fail in shear? In most foundation problems, the question of shear will not be serious but occasionally it will and when it does it will control the design of the entire structure. Turning our attention to settlement, three methods of approach are possible: (a) field loading tests: (b) laboratory consolidation; and (c) penetration resistance. The use of tables, such as those that are included in many building codes, is largely empirical and of little help in estimating total settlement. Empiricisms based upon classification must obviously be totally inadequate, except in the case of pedology where the geologic history is included in the classification. However, it is doubtful that any engineer hopes for a good estimate of total settlement when utilizing empirical guides that do not specifically include settlement as a variable.

Regardless of the technique used for estimating the allowable soil bearing, the pressure exerted by the structure must be estimated from the total live and dead load and some assumed foundation design. In some analyses discussed later, there is a need for the pressure transmitted to various depths beneath the surface. This is normally accomplished by charts and graphs based upon the Boussinesq or Westergaard solutions for elastic materials. While soils under foundation-type loadings do not approach having these characteristics for estimates based on the elastic theory, the vertical pressure is considered to be reasonably close. The following is one commonly used form of the Boussinesq equation for obtaining vertical pressure at any point under a point load and referring to Figure 17:

$$\sigma_z = Q/2\pi \times 3z^3/R^5 \quad \ldots\ldots (14)$$

where:

σ_z = vertical pressure in lbs. per sq. ft. at point A.
Q = total load in lbs.
z = depth in ft. of point A
$R = r^2 + z^2$, and r = horizontal distance in ft. from the load application to point A.

The importance of the results of the pressure estimates is illustrated

Table 4—Allowable Soil Pressures for Small Structures*

Standard Penetration Resistance N	*Cohesive Soil Types Tons / sq. ft.*	*Non-Cohesive Soil Types Tons / sq. ft.*
1 to 5	0.1 to 0.5	0.1 to 0.5**
6 to 10	0.5 to 1.5	0.5 to 1.0
11 to 20	1.5 to 3.0	1.0 to 2.0
over 20	3.0 to 5.0	2.0 to 5.0

* Based upon maximum settlement of one inch, and a maximum differential settlement of ¾ inch.

** If below water table, use piles, piers, or compact.

in Figure 17, where it can be seen that the depth to which an appreciable pressure is transmitted is approximately twice the footing width. Thus, for a five-foot footing, the vertical pressure at 10 feet is somewhat less than 0.1 as great as the applied load. For very high structures, the depth to which a significant pressure is transmitted can be quite great.

To obtain total settlement, one must consider each soil stratum. If there is one that is significantly weaker within the effective depth, then it will control or contribute the only significant settlement. Thus, a firm sand layer can be neglected if a soft clay layer is involved. The test results needed to estimate settlement depend a great deal on the soil conditions in the field. Laboratory consolidation tests apply only to saturated clays. Penetration tests give one empirical method for estimating settlement of any type of material. Load tests are possible, but the effective depth problem in Figure 17 is involved; i.e. if a 1-foot square plate is used, the test does not reach much more than two feet below the level of the plate.

Predicting total settlement is a problem for the specialist, but keeping settlement within tolerable limits for small structures can be accomplished by careful use of the standard penetration resistance data as shown in Table 4. Fortunately, only soft clays and loose, fine sands offer serious total settlement problems, and such cases should be referred to the specialists.

The problem of rate of settlement is even more complex than is the one of total settlement. In fact, except for saturated soft clays that have never been heavily pre-loaded, there is no established theory for dealing with such problems. Rate of settlement is infrequently needed, and should normally be referred to an experienced soils engineer. Sand drains under embankments are one type of application in which the settlement rate is critical.

Differential settlement is undoubtedly more frequently a problem than is simply total or rate of settlement. Essentially, the problem is one of estimating total settlement at various points under the foundation. Generally, settlement differentials greater than one to two inches can produce serious cracking throughout the superstructure.

In many cases, a qualitative understanding of differential settlement will permit better design. It is reasonable to expect two different soils or soil strata to produce different amounts of total settlement. Therefore, everything should be done to avoid radical changes within one foundation. When soil variation occurs (changes in type of soil) nothing can be done in many instances. Uniformity of support accounts in part for the old (and outdated) theory that house foundations should be placed on natural ground. The fact is, a compacted fill can give more uniform and better support than an uncompacted natural soil deposit. On the other hand, an end-dumped, ill-placed embankment would produce a wide variation in support, thus producing large differential settlements. The Federal Housing Administration now permits the placing of footings on compacted fills, largely through their experiences in the Los Angeles area. (See Figure 18.)

Perhaps the most serious problems in terms of differential settlement arise when half the structure is founded on bedrock, piling to rock, or other type of near-rigid support while the remainder is on soil. When such conditions are inevitable, so, too, is differential settlement and the two parts of the superstructure should be designed in such a manner as to minimize the differences.

● **FIGURE 18. Construction of a development in Beverly Hills, Calif. Footings for the residences were placed on a stepped series of well-compacted foundations.**

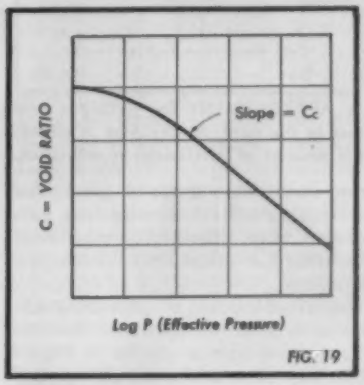


FIG. 19

● **RESULTS of the consolidation test.**

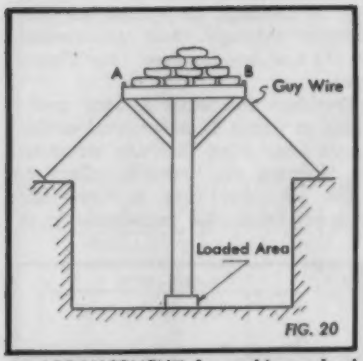
The basis for computing total settlement by the laboratory method is the consolidation test, the results of which are frequently plotted on a semi-log basis as shown in Figure 19. The total change in volume that is produced by each load increment is expressed as a change in the void ratio as defined in equation (6). The slope of the straight portion of the e-log p curve is termed the compression index, C_c, and is in effect the rate of change of volume with unit load. The settlement (S) in a given layer can then be computed from an equation of the form:

$$S = H \frac{C_c}{\Delta p \ (1 + e_o)} \log \frac{p_o + \Delta p}{p_o} \quad \ldots\ldots(15)$$

where;

S = Settlement of the strata in inches
C_c = Compression index
H = Thickness of the layer in inches
Δp = Change in effective pressure, lbs. per sq. in.
p_o = Initial effective pressure, lbs. per sq. in.
e_o = Initial void ratio

The pressures utilized in equation (15) are *effective pressures* which



● **ARRANGEMENT for making a load test in the field. As the load is added, the amount of settlement is measured.**

represent the grain-to-grain (or submerged effect) stresses in a saturated mass. Therefore, care must be taken in attempting to use the equation.

Another method of estimating settlement is on the basis of conventional load tests as shown in Figure 20. The data are normally plotted arithmetically, and the allowable pressures determined by arbitrary standards related to the settlement or from the break-point in the load-settlement curve. From the practical viewpoint, the field test procedure is available from many sources and is outside the scope of this discussion. The load, however, is normally a readily available one such as bags of cement, concrete blocks, bricks, etc. Settlement is measured by instrument levels taken at benchmarks (A and B) on the platform.

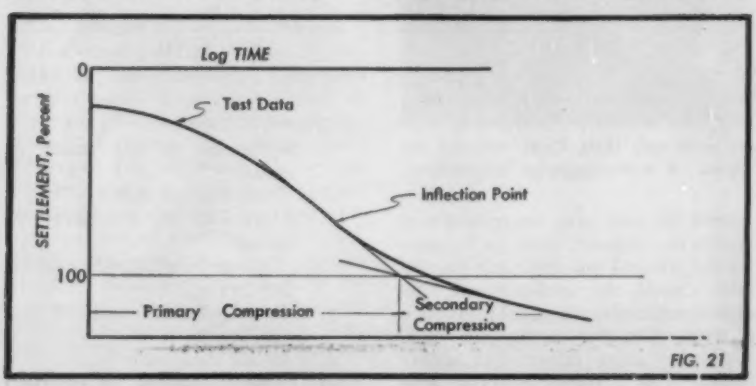
The choice as to type of foundation is a complex one, and normally a direct function of economy. Occasionally, however, the soil condition will dictate the type of solution. For example, fine sands that are not densely packed and which lie below the water table cannot normally give reliable support and piling extending to a firm stratum is essential. As to types of foundation, Table 5 summarizes the various kinds, and their application. A more detailed consideration is outside the scope of this discussion.

Table 5—Types of Structural Foundations

Type	*Remarks*
Footings (Continuous, rectangular and square)	Commonly used on small structures or on large structures as wall or column footers where good foundation material is available.
Piling (a) Bearing	Carries load through soft material to firm soil or rock stratum. Particularly useful where deep, soft clays are encountered.
(b) Friction	Load carried by shear resistance (commonly termed friction) between soil and pile where soil can provide adequate shear but not satisfactory for footer.
(c) Combination	Both end-bearing and frictional resistance are developed.
Raft	Structure is "floated" on soil foundation where piling would be more costly and footers would cover over 50% of the base of the structure. Danger in placing raft under tall structure (relative to size of base) on clay since differential settlement and tilting could lead to collapse.
Pier	Carries load directly to firm strata because of economy. Normally, poor soils are encountered above good strata, and it is more or equally economical to excavate rather than to use piles or raft.

It was noted earlier that the rate of settlement is particularly difficult to predict in an accurate manner. Figure 21 shows a plot of the degree of consolidation vs. time for a given load increment. The degree of consolidation U (percent) is equal to the ratio of the settlement (S) at any given instant to the ultimate settlement (S_∞) if the load were to remain on the sample indefinitely. Part of the problem of predicting rate of settlement is associated with interpreting data of the type shown in Figure 21; i.e., extrapolating to time intervals much greater than the time used in making the test.

The foregoing merely illustrates the settlement problem and shows the principles that affect estimates of settlement. There are many refinements required and much "art" still remains in the actual practice of foundation design using soil engineering theory. Important problems should be delegated to qualified specialists.



● **THIS PLOT shows degree of consolidation vs. time for a given load increment.**

Stability Problems

As stated previously, stability of a soils mass is concerned with shear, no matter whether a foundation or a slope design is involved. The major question that the analyst must answer is whether the soil will be able to resist the stresses imposed.

One of the trickiest problems is stability and one that is quite likely to cause concern is the determination of the surface upon which shear will occur. It is difficult to visualize this surface without some understanding of soil. To begin with, soils in large masses tend to fail along circular surfaces (in two dimensions). While the surface is not truly circular in cross-section, such an assumption is sufficiently close for practical purposes. The actual location of the surface can be almost impossible to predict, but some general guides are available, particularly for new embankments. In many cases, an assumed location is

sufficiently accurate to permit a reasonable analysis of the problem. The important factor for the moment, then, is that *soils tend to shear along circular surfaces unless some local influence produces a more nearly straight* surface. Soils also tend to behave normally in that they shear along paths of least resistance as can be seen in Figure 22.

A second important consideration is the procedure followed in the analysis. Essentially, the design involves satisfying the following equation for the Safety Factor:

$$S.F. = \frac{\text{Shearing resistance}}{\text{Shearing stress}} \quad \ldots 16$$

The analysis, then, is concerned with determining the safety factor for the shear surface that is most critical, and two values are needed; i.e. resistance and stress.

The determination of stress consists basically of the procedure indicated in Figure 23. The mass and structures that are above the shear surface provide *all* the significant source of stress. (While not precisely correct, the preceding statement is sufficiently close for most analyses). By dividing the mass into comparable width increments, individual weights (W) can be obtained. For each increment, the weight is resolved graphically (or arithmetically) into two components—one that is tangent and one that is perpendicular to the shear surface at the midpoint of the increment. The stress for this increment is the tangential component, and the total stress above the surface for all increments is the sum of the tangentials—usually designated as Σ T. *The total of the tangentials in pounds or tons represent the only significant force tending to move the mass along the surface.*

As to shearing resistance, equations (9), (10) and (11) are of interest. For convenience, equation (9) is repeated here:

$$s = p \tan \phi + c \quad \ldots\ldots (9)$$

It will be recalled from the earlier section on strength properties that the frictional part of the shearing resistance along a surface is influenced by the "normal" (or perpendicular) force. Bg summing the perpendicular forces of Figure 23, the total force (ΣN) contributing to shearing resistance is available. Finally by multiplying the unit cohesion by the length of the shear surface (l), the total shearing resistance is available and equation (16) becomes:

$$S.F. = \frac{\Sigma N \tan \phi + cl}{\Sigma T} \quad \ldots (17)$$

For granular soils, since c = 0

$$S.F. = \frac{\Sigma N \tan \phi}{\Sigma T} \quad \ldots\ldots (18)$$

For highly cohesive soils, since $\phi = 0$

$$S.F. = \frac{cl}{\Sigma T} \quad \ldots\ldots (19)$$

In considering stability problems, one should delineate for convenience, the problem of whether a foundation or slope is involved. In most cases, shear problems under structural foundations will not exist unless a very soft material underlies the area. For these cases, the location of the shear surface and the measurement of shearing resistance are most critical. Figure 22 suggests the type of shear surfaces that can be anticipated in foundation problems. For slopes, there are embankments, trenches, and cuts in natural slopes to be considered most frequently. These, too, are shown in Figures 22 and 32 (see next installment).

The least dependable factors in stability analyses are the values that define shear, i.e. ϕ and c. Part of the problem is that the values vary from time to time as the unit weight and the moisture content change. If a new embankment is under study (or any other analysis involving compacted soil), a laboratory procedure for obtaining the shear factors is quite satisfactory. However, serious difficulties are encountered in obtaining ϕ and c for soils in place, or for soils that will undergo structural change after the load of the structure is applied. Laboratory tests on undisturbed samples are one possibility. A second method is based upon considering the shear surface and the entire mass as a full-scale shear test. By assuming the safety factor of equation (17) to be unity, and by assuming a reasonable range of values for ϕ (not difficult with experience), the only unknown in equation (17) is c. As a result, pairs of values for ϕ and c can be utilized in analyzing the effect of the design.

Another logical question is what to do if the safety factor is less

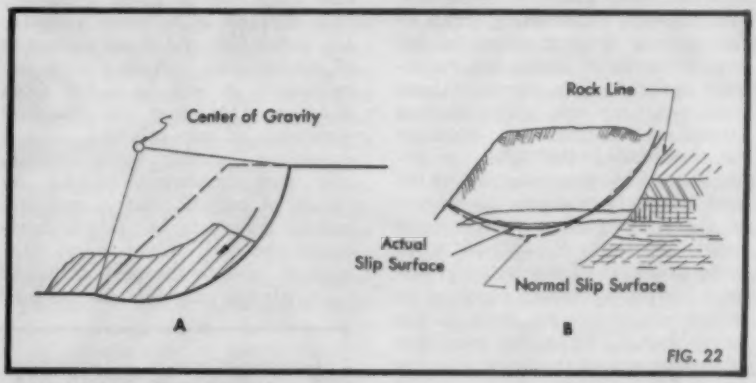


FIG. 22

● **NORMAL path of shear is a circular surface, as shown in "A" above. However, presence of rock (as in "B") or other factors may change path of least resistance.**

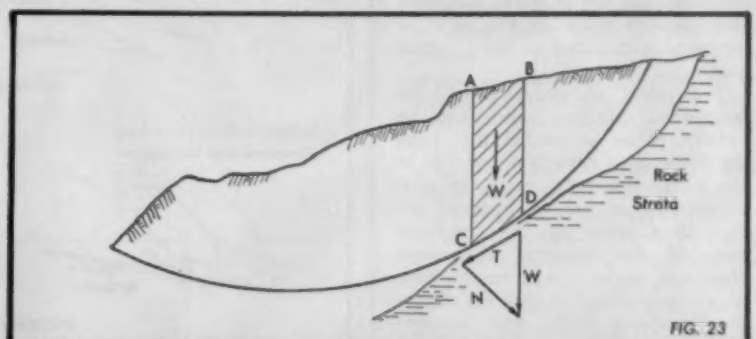


FIG. 23

● **DETERMINATION of shearing stress. Weight of width increment, W, results in a force T tangent to slip surface. Summation of these forces tends to move mass.**

● **FIGURE 24. Terrain subject to slides. This is on US Route 50 in Colorado.**

than a tolerable value. (The "tolerable" value of the safety factor varies with organizations but is rarely greater than 1.5). Only one of three basic alternates exist; (a) increase the shearing resistance, (b) decrease the shearing stress or (c) provide a combination of the two. Methods of increasing resistance include piling, earth or rock mass near the toe, walls, shoring (trenches), stabilization, drainage, etc. Decreasing the stress is accomplished by removing part of the load, particularly above the portion of the shear surface that is most nearly vertical. Figure 25 gives some examples of increasing resistance and of decreasing stress so as to achieve a proper level of the safety factor. When the technique of assuming a safety factor of unity is used to evaluate shear properties, the desirable or design safety factor may be equal to unity (thus not changing the stability condition that existed prior to the new or proposed structure) or to a higher value.

The effect of water should be mentioned. Moving water can be considered as increasing the driving force in a direction parallel to its path. However, one can also consider it as only a buoyant effect—thus reducing the frictional part of the shearing resistance. Drainage under such assumptions would tend either to increase shearing resistance under one perspective or to increase driving force under the second. No matter which analysis is used, the theoretical results are the same if properly handled.

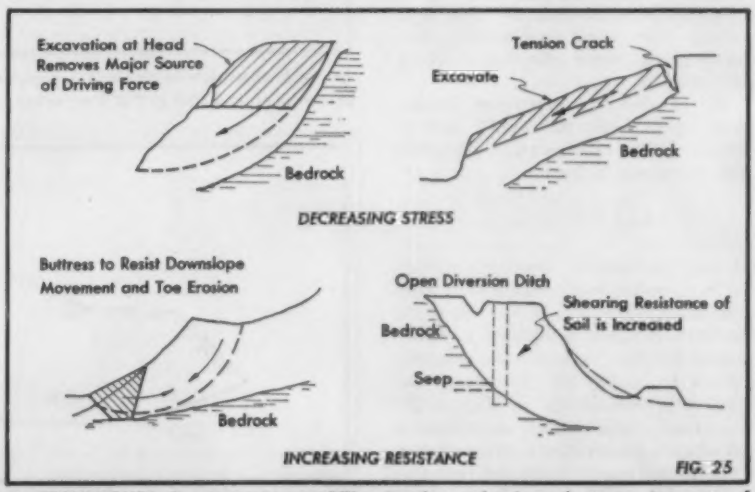
The most commonly encountered stability problems are concerned with embankments, and the proper side slope for a given condition. The differences between granular (or rock) fills and those composed of fine-grained cohesive soils are important. It will be noted from equation (10) that the shearing resistance of non-cohesive soils is dependent entirely upon friction, and such materials assume an "angle of repose" that is approximately equal to ϕ (1½:1—horizontal:vertical). There is no theoretical limit to the vertical height to which granular fills can be constructed to these slopes, but normal conservative design requires 2:1 to 3:1 for fills 50 to 200 feet in height.

Cohesive soils do not act the same, however, particularly as to "angle of repose" and critical height. For example, in trench excavations, vertical slopes for depths of 10 to 15 feet may not cave in for extended periods of time for clays, but would fail immediately in clean dry sands. On the other hand, some clays will not be stable in embankments that are 30 feet in height built with 1½:1 slopes. The reason, of course, is that the frictional part (ϕ) of clays may be negligible, and all of the shearing resistance is traceable to the cohesion, and cohesion does not increase appreciably with increase in the normal force. Therefore, *there is a critical height for cohesive soils for any specific slope angle.* For properly compacted embankments, assuming that organic clays are not used, most soils are stable on 1½:1 for heights up to 50 feet. These heights assume one other factor, and that is, that the foundations are adequate.

In summary, the purpose of design relative to a stability problem is to increase the ratio between shear resistance and stress. Therefore, solutions provided or alternates that are possible can be examined, even on a qualitative basis, in terms of their ability to affect that ratio.

Permeability

The conventional problem concerned with permeability need only have brief attention here. It should be remembered, however, that for all practical purposes, the maximum flow through different materials along the line of flow is con-



● **TECHNIQUES for improving stability involve reduction of stress, increase of resistance, or combination of the two. Typical methods are shown in sketches above.**

trolled by the amount that can get through the most impermeable layer.

For earth dams, the loss through or beneath the dam requires some estimate of the head loss, the length of flow, the coefficient of permeability, and the cross-section of the minimum area through which flow occurs. The head loss (h) is simply the drop in elevation from the pool stage to the outfall (see Figure 26). The average length of flow can frequently be obtained with sufficient accuracy by determining the average length of the path the water must take to get through the most impermeable layer. Thus, if there is an impermeable core, surrounded by relatively permeable material, the gradient through the core represents a good value for establishing the flow through the dam. The difficulties in obtaining a reliable coefficient of permeability were discussed previously, and the most important consideration is the testing of the soil under comparable unit weight and soil structure conditions.

The permeability of pavement base and sub-base courses is of interest. Frequently one encounters the opinion that if a material is essentially granular it will be permeable. Actually, permeability depends upon grain size only in the sense that *possibilities* for larger void spaces exist for the larger sizes. If a long-graded material is used, the voids are filled and a relatively impermeable material exists after compaction. In fact, if a base course tightens into a compact mass then it is probably quite impermeable. In contrast, a macadam base (composed of one-sized material) prior to choking, and even after choking in many cases, will be relatively permeable. The strength of the base course, however, is not necessarily related to the permeability.

Permeability of the soil drastically affects its ability to be drained; i.e. low permeability materials are difficult to drain. Use of sub-drains in uniform clays may not appreciably affect the water table, particularly if only a two to three-foot drop is involved. In any event, in impermeable materials, the drains must be placed much closer together—sometimes as close as 10 feet in order to obtain a one to two-foot drop in the water table. Where thin layers of permeable materials are interbedded or pocketed in an essentially impermeable material, the drains should be placed lower than the permeable strata.

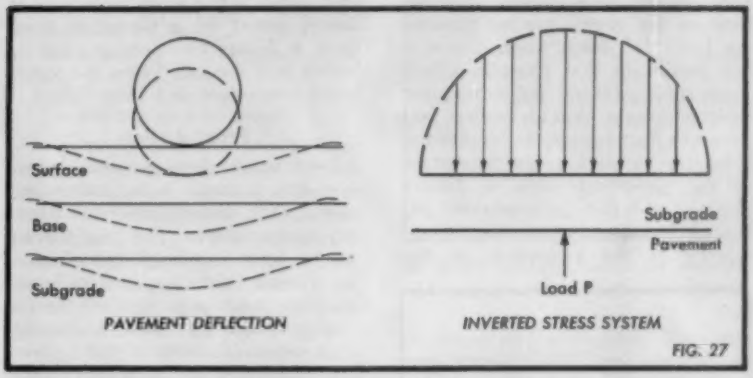


FIG. 27

● **PAVEMENT stresses, which are transmitted through the surface and base to the subgrade, cause deflections each time a load is applied. The inverted stress system is sometimes used to analyze the amount of stress applied to the subgrade soil.**

SPECIAL PROBLEMS

Many civil engineering problems that are encountered involve some factor of soil behavior which appears highly specialized, and one that might not appear to fall into one of the three basic categories of (1) stability; (2) settlement; or (3) permeability. Furthermore, if the three considerations are not kept in mind, empirical techniques that combine the stability and settlement factors may not reflect the fundamental problem involved. It is this fundamental understanding, however, that will remove most of the mystery of soil engineering. In the remainder of this article, the following problems, and the basic soil considerations involved, will be discussed: (1) pavement design; (2) frost action; (3) pumping; (4) shrinkage and swell; and (5) sand drains.

Pavement Design

Highway and airport pavements are concerned with a structural slab and its foundation. Both stability and settlement problems exist. One of the most difficult parts of the design is a reliable, accurate estimate of the stresses that exist, and the stresses are needed in order to complete both the stability and settlement analysis. Relatively recent analyses based upon work by Westergaard and by Burmister have developed ways of obtaining the stresses. Even more recently, advances in understanding the influences of the rate of loading are leading towards more rational analyses of pavement and subgrade stresses.

Regardless of the ability to handle the stresses or the resistance of the soil to those stresses, the two phases of the problem are shown in Figure 27. The magnitude of the stresses on or within the subgrade are affected by the pavement thickness—the greater the thickness the lower the stress. The settlement develops under minute, permanent deforma-

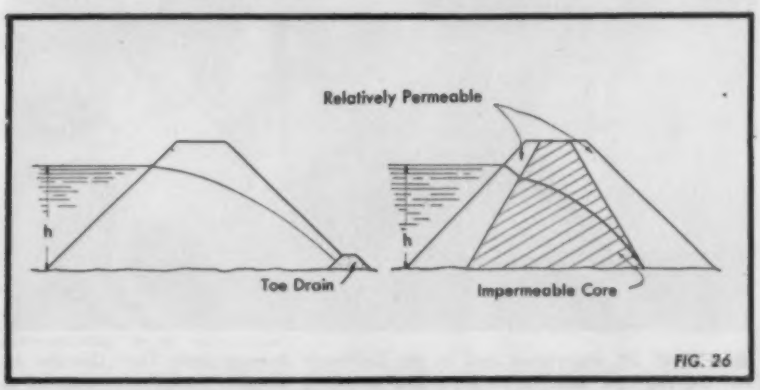
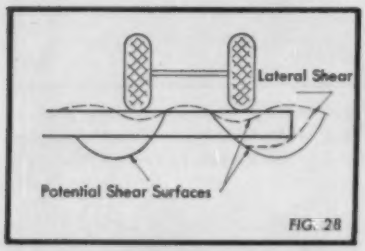


FIG. 26

● **FLOW LINES through earth dam. Impermeable core produces desired resistance.**

tions under each load until such time as the grains are as close as the loads can force them. There is the possibility that climatic effects cause some swelling and subsequent recompaction so that an endless settlement effect appears to be present.

Insofar as stability is concerned, at the pavement edge, a failure along a circular path can be assumed. Inability to compute the influence of the pavement on the



● **SHEAR problems in pavements. These may take the form of a type of circular failure or lateral displacement along the side or edge of the pavement.**

stresses has prevented an accurate analysis of this type of failure. In the center of the slab, a different condition exists. As seen in Figure 28, two types of shear can take place; one is a type of circular failure, and the other is a lateral displacement parallel to the bottom of the pavement. For this latter type, small permanent deformations can be compounded until support is removed from beneath the central portion of the slab. Such action is accelerated by the larger stresses that are imposed by heavy loads. For the circular failure, no shear of the soil can occur until the pavement itself has failed, which says in effect that the pavement increases the resistance of the soil to shear.

Most empirical procedures for testing soils (CBR, North Dakota Cone, Penetrometer, etc.) develop data that indicate the resistance of the soil to a type of shear. However, such procedures only reflect the resistance of the subgrade to *the type of load used in the test* and do not develop soil resistance data useful to a stress analysis. Since stress analyses can not yet be rationally accomplished, many different empirical methods have developed. Thicknesses are obtained by correlating the empirical soil tests with pavement performance. Given the soil value and the traffic, the thickness is obtained by equations or from charts. Figure 29 shows the equipment utilized in the CBR test —one of the most frequently used of the empirical tests. The soil is compacted in the mold, permitted to absorb water for a period of time, then a 3 sq. in. circular disk is forced into the soil. There is a combined settlement and shear effect.

Frost Action

Frost action develops where there are fine-grained soils (silts and clays), high water tables, and freezing temperatures. For engineering works, frost problems are encountered under slabs exposed to freezing temperatures particularly at the edge of foundation slabs. Essentially, frost action consists of the following: (1) water moves upward from the water table by capillary action; (2) when temperatures drop below freezing the water in the voids is frozen; (3) water continuing to move upwards freezes upon contact with the ice crystals; and (4) the particles of ice increase in size, forcing the soil grains farther apart. The shapes of these ice particles are varied but can grow to several feet in length and several inches thick, forming lens-type masses.

If the soil-ice material would not thaw, the only problem would be a steady raising of the area. However, in the United States, where ice lenses always melt during the spring thaw, a special problem develops. During the thawing period, the enlarged voids are nearly filled with water, and a jumbled mass of soil, water, and ice exists. Even though the water tends to drain away, a significant length of time is required. In the meantime, if traffic goes over the pavement, a greatly reduced shearing resistance is present in the soil and a correspondingly larger part of resistance to the load must be provided by the pavement. It is during this period that the so-called "spring break-up" occurs.

Silt soils are the worst—even more troublesome than clays—insofar as frost action is concerned. Since greater heights of capillary rise are possible in clays, this may appear to be a contradiction. However, the more *rapid* capillary movement in silts provides more water for the ice-lens formation, thus producing larger lenses and greater voids for the spring break-up. Therefore, if the water table lies within 5 to 10 feet of the pavement, and silt subgrade is present to that depth, the worst condition possible for detrimental frost action can develop with extended cold periods.

It is important to note that frost action reduces to a stability problem in the spring. Frost action is commonly counteracted by the use of frost-free (non-lens forming), granular material to depths greater than the depth reached by frost. However, for border-line cases, increasing the shearing resistance of the pavement could produce the necessary resistance. Other techniques based upon a more rapid drainage

Photo courtesy The Ohio State University

● **FIGURE 29. Apparatus used in the California Bearing Ratio Test. Grouped at left are the CBR mold, swell plate and surcharge weights. Compaction hammer is at center. Assembled mold with triped attachment and dial indicator is at right.**

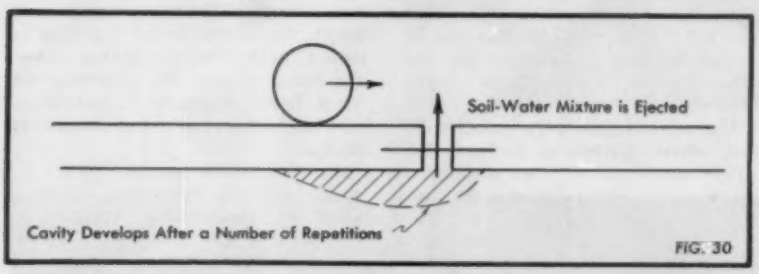
during the thaw cycle or a reduction of the capillary rise are of potential use.

Pumping

The pumping problem on rigid pavements consists of the forceful ejection of water-suspended subgrade soil under the action of heavy traffic. The action occurs at the edge or at a crack or joint, and is quite comparable to the action of any conventional pump. From a soil behavioral viewpoint, a settlement problem develops first, producing a cavity as shown in Figure 30. Subsequently, water entering through the crack or joint or along the edge fills the cavity. Loads that deflect the pavement place the water under pressure and it squirts out to the surface carrying particles of soil with it. The action continues, enlarging the cavity, thus placing greater stress on the unsupported pavement.

Conventionally, pumping is eliminated at the design stage by incorporating a granular material which is either too large to be carried in the water (same principle as utilized in the hydrometer analysis) or is too big to get through the crack or joint. The granular material acts as a kind of filter, keeping the fine-grained silts and clays from working upwards to the pavement and being ejected.

Since the problem develops in the first place due to settlement (or possibly the lateral shear mentioned under "Pavement Design), reduction of the stress should reduce the possibilities of developing pumping. For borderline conditions, such is the case. However, on main traffic arteries, the probable continued increase in heavy loads would tend to suggest that some permanent settlement will develop, so granular courses will be necessary in almost all instances of fine-grained subgrades.



● **PUMPING problem is caused by the repeated displacement of water-suspended subgrade soil through a crack or joint. As cavity grows, stress becomes greater.**

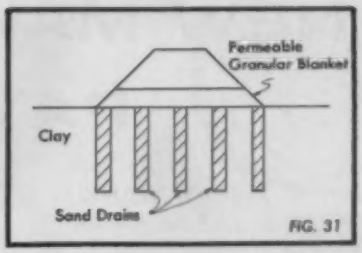
Shrinkage and Swell

In some parts of the world, there are soils that undergo great volume change whenever water is added or removed. For cases of volume reduction (shrinkage) the problem is one of settlement, since the shearing resistance will undoubtedly increase. On the other hand, volume increase produces "negative" settlement, either uniform or differential uplift, and the shearing resistance is decreased.

In rare cases, the shearing resistance is a factor. More frequently, the dislocation of the structure, or the differential "positive" or "negative" settlement. The control of the volume change can be effective in minimizing damages if control can be achieved through drainage (to control swell) or maintaining a constant moisture content (to control shrinkage).

Sand Drains

One of the frequently mentioned techniques for controlling a foundation failure under an embankment on soft ground is sand drains. In addition to eliminating shear failures, the drains are considered to be of value in accelerating the settlement by providing an easier path for the water to get out of the clay. Sand drains are somewhat controversial since all soil engineers do not agree as to their ability to produce drainage in accordance with the consolidation theory. It will be recalled that when saturated clays are loaded (Fig. 31), the soil grains are forced closer together, thus placing the water in the voids under pressure. As time passes, the water drains away and settlement ceases or is reduced in rate. The vertical sand drains and the horizontal granular blanket provide a more ready exit of the water under pressure in the voids.



● **SAND DRAINS under an embankment constructed on clay foundation.**

The use of sand drains is closely tied to the rate of construction. From the stability viewpoint, there is a maximum embankment height (or load) which the soft ground can withstand without failing in shear. However, as time passes, the soil particles are forced closer together (unit weight increases), and the resistance of the soil to shear is increased. The use of sand drains tends to increase the rate of strength change, thereby permitting more rapid completion of the fill. This is accomplished by constructing the embankments in increments of height, each increment being the computed maximum height that the foundation soil can take without failure in shear. The sand drains do not materially affect the amount of settlement—only the rate—and consequently the rate of buildup of strength.

The theory as to the spacing of the sand drains is not well defined, and to a great extent is an art. With experience, the ability to design the spacing will improve. By constant measurement of the settlement following the completion of each height increment, one can judge as to the feasibility of starting the next increment. The use of laboratory consolidation tests offers an opportunity to estimate the time, but due to the inherent difficulties associated with laboratory consolidation, the field observations are essential. Sampling and testing of the partially consolidated foundation material will also be useful in judging the ability of the foundation to withstand more load.

Part III of this series, "Construction Applications," will appear in the April issue.

NEW MAIN STREET LIGHTING PAYS FOR ITSELF

J. JORDAN YOUNG,
First Deputy Commissioner of Public Works, White Plains, New York

LAST summer the City of White Plains, New York, after a careful study of the lighting system for Main Street, decided to redesign the whole system. The old 16-foot king poles had become a little loose on their foundations due to the deterioration of the holding bolts in the concrete bases. When backed into by parking cars, the poles tended to vibrate enough so that the glass globes on the top were easily broken. During one year as many as 50 globes had to be replaced at $18 each.

The 10,000-lumen lamps were believed to have an efficiency of only 60 percent. The power for the sixty 585-watt incandescent lamps, and the rental from the power company of some 4,000 feet of underground cable and other control facilities, cost the City of White Plains about $4,400 a year.

There was also a need for more light on the pavement surface during the late hours when the bulk of the store front lighting was turned off. This, of course, was highly endorsed by our chief of police in the interest of crime prevention.

We looked over what was available and finally came up with a combination of a 26-foot aluminum pole, an 8-foot tapered upsweep eliptical bracket and a mercury vapor luminaire of 21,000 lumens. We chose the power pack variety with combined ballast luminaire and photo electric light switch, all in one compact unit.

This combination provided a number of advantages. Instead of 60 poles and lamps, we had 30. The spacing was arranged originally with poles on opposite sides of the street, 100 feet apart. The new spacing alternated one on each side of the street in the same locations as the old poles. Due to the increased efficiency, more light was gained at the pavement surface with much less maintenance.

By using photo electric light switches we were able to save the rental on the cable and control facilities. The underground conduits went to the bases of the old poles and the cables could be changed to secondary lines; consequently no expensive street openings were needed.

The street lights were installed 30 feet above pavement surface. No breaking of glass, we believe, will occur at this height, potentially quite a saving in maintenance costs for the street.

The cost to install the 30 units was $11,270, including pole luminaire and concrete base. The cost of energy for the new installation will be about $1,500, so that in about four years this installation should pay for itself, and thereafter show a saving of some $3,000 per year.

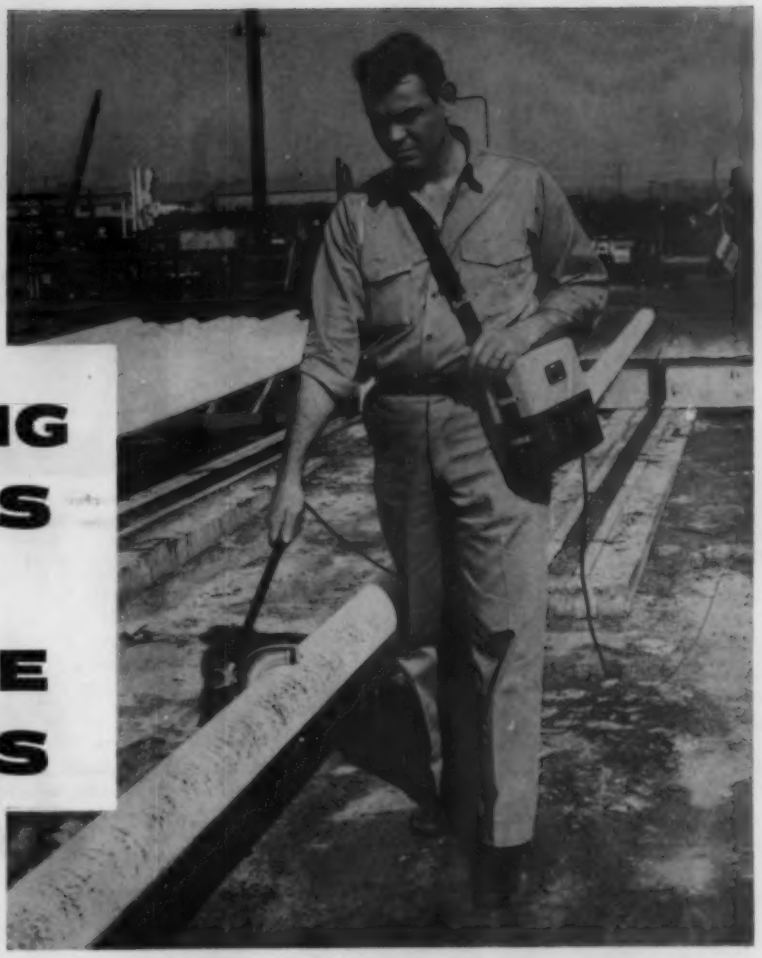
The business people along the street are well pleased with the installation and made separate contracts with the aluminum pole supplier to have waterproof outlets inserted 15 feet above the walk for Christmas decorations.

The luminaires selected from competitive bidding were the new General Electric power pack M-400, and were some of the first units of this model to come off the assembly line for street light installations. The aluminum poles and brackets were furnished by Pfaff & Kendall.

White Plains is very proud of its new street lighting program, of which the Main Street lighting is just a part. The residential areas are being studied and many areas have been improved. Lighting is now made a part of every new street design.

● **ADEQUATE lighting for White Plains: P & K 30-ft. aluminum standard with 6-ft. tapered arm supports GE M-400 Mercury Vapor luminaire.**

● **DAY VIEW of installation showing luminaire and receptacle on shaft for decorative lighting.**



● PIPE line detector employs high voltage DC for locating holidays, voids and thin spots in pipe coating; but it can be used also on horizontal surfaces.

DETECTING HOLIDAYS IN PIPE LINE COATINGS

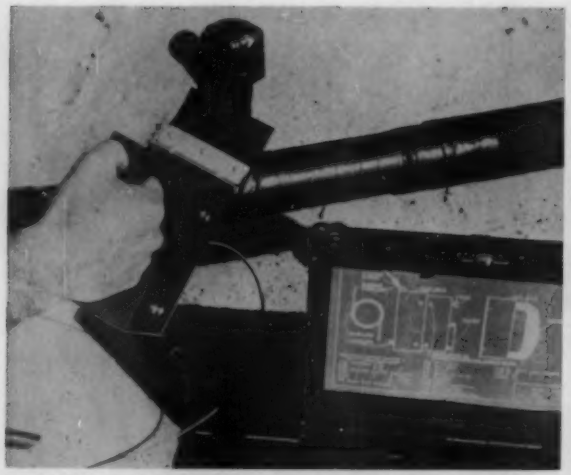
●

IF A LINE is perfectly insulated with a non-conductive coating or wrapping, no cathodic protection is needed. If there is one hole in the wrapping, however, cathodic protection is needed and a given amount of outside current is required. More such holes or holidays require a larger amount of current, with a corresponding increase in cost. While experience has shown that initial current requirements are almost always low and the number of cathodic protection stations required are few, if the quality of the coating is poor soil stress and movement of the pipe through heat expansion may cause existing thin spots to fail, with increased need for protection.

A method of minimizing this is to check the pipe line with a holiday detector and repair any thin spots, pin holes, or discontinuities before back filling. Modern pipe line detectors are generally portable and can be operated by one man. In most cases the detector and accessories are carried in a case, slung over the shoulder while the electrode is mounted on the end of a wand which is rolled or swept over the coating. While the detector has a relatively high potential output, there is no current flow until it passes over a void or thin spot. When these are encountered, a signal is given to indicate the location. Used in this manner, one man can be a complete inspection team.

Causes of Holidays

An electrical holiday detector is used following a coating operation to inspect all surfaces of the coated pipe to locate pin holes, bare spots or any point at which the electrical resistance of the coating is abnormally low with respect to the total surface. Areas of electrical low resistance can be produced from inclusions of coked bituminous material, rust scale from an improperly cleaned pipe surface, dirt, rocks or gravel and in some cases, water spots or oil drippings. The latter two usually result in paths of low resistance because gas is formed and bubbles result. Sometimes in the application of hot bituminous material there is a small amount of moisture on the surface of the primed pipe. When the hot material strikes the pipe, gas bubbles will be formed so that the nominal thickness of the coating will be reduced. Trouble may occur at times because most bituminous coatings are now reinforced with glass mat or fibers, imbedded in the coating from a spool on the coating machine. If the bituminous coating does not completely wet this mat of fibrous material, a path for air or water is opened between the surface of the pipe and the surface of the coating through the bundles of glass fibers. Most operations use an overwrap to protect the coating from physical damage during handling and subsequent installation in the ground. It is obvious that when this overwrap goes on immediately over the coating all of the defects in the coating



● PORTABLE hand detector is for electrical inspection of pipe wrapped with tape, for testing field joints and fittings.

● BURIED pipe line detector, Pearson type, not only locates pipe line but also detects holidays in the buried line.

are masked from visual observation. The electrical holiday detector will generally indicate these deficiencies and show the exact spot at which a deficiency exists so that a quick repair can be made.

Many miles of high pressure transmission lines are coated over the ditch so that the fabrication of the coating film is done in the field under adverse conditions. Proper heating temperature, priming methods and other such measures can be observed by an inspector. The final result, however, can be observed only by a holiday detector. A substantial extra benefit through the use of a detector is that everyone on the job is aware of the quality of work desired, and at times this can make a significant difference.

HIGH PRESSURE WATER LINE CROSSES INTRACOASTAL WATERWAY

C. E. WRIGHT

MANALAPAN is a 270-acre exclusive resort colony on the lower Florida east coast, 15 miles south of Palm Beach, extending approximately 14,000 ft. between the Atlantic Ocean and Lake Worth, the Intracoastal Waterway. Harold S. Venderbilt is mayor of this small unincorporated municipality in which there are only 65 freeholders. Hemmed in between the two bodies of salt water, Manalapan had a problem of salt water intrusion, so it has built a new water system, bringing its fresh water supply from wells constructed approximately two miles west of the coastal highway, U.S. 1. An interesting phase of this new system is the method by which high-pressure water main was designed and laid across the Intracoastal Waterway.

For the 1,800 ft. long underwater crossing, the engineers selected 10-in. dia. extra heavy Byers uncoated wrought iron pipe welded with wrought iron split sleeve couplings. A unique method was employed in placing the welded wrought iron pipe in a previously prepared trench. The 20-ft. random pipe lengths were coupled together on work horses placed ashore adjacent to the job site. Seven 20-ft. lengths were welded together using both transverse and longitudinal welds, pneumatically tested for leaks, then pulled across the water in a single continuous operation and lowered into the trench by means of a floating barge and donkey engine. Maximum trench depth was 17.5 ft. below mean sea level. Divers inspected the pipe and couplings before a backfill of 30 in. of sand was applied for cover. There was also a short separate underwater crossing, using 8-in. dia. wrought iron pipe from an adjacent exclusive land development known as Point Manalapan. The entire underwater crossing operations required less than three days construction time.

To provide the new water supply, two 180-ft. deep wells were sunk sufficiently remote from the ocean to avoid danger of salt water contamination. This ground water was found to be of excellent bacteriological and chemical quality, free from odor, color, iron and chlorides, with a pH of 7.5 and a total hardness of 154 mg/L.

The wells were drilled by rotary rigs using welded steel casing pipe, concrete grouted in place and protected by a Johnson Everdur well

● WATER crossing preparations: Pipe was laid on horses and seven 20-ft. lengths joined and sunk in prepared trench.

● PIPE HAS been welded together and is ready to be hauled into position and placed in prepared trench. Note line marker.

screen. The raw water is pumped through Johns - Manville asbestos cement pipe for approximately two miles by 250 gpm. Deming deep well turbine pumps, one at each well, into a 300,000 gal. welded steel ground storage tank, furnished by the Whitmire Tank Co., Jacksonville, Fla. In the tank, the water is stored and treated with chlorine and polyphosphate. The water is metered at the storage tank influent by a Sparling main line meter.

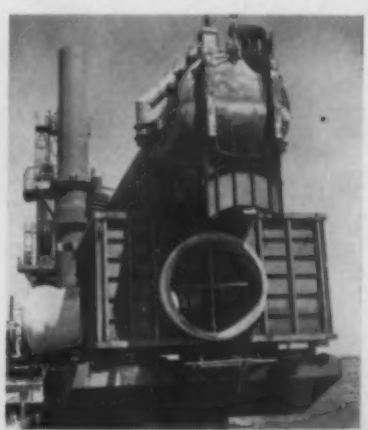
An existing high-pressure water pumping station was rebuilt and utilized for delivering water from the mainland storage tank to island and oceanfront consumers. This station includes three Nash centrifugal single stage, split case water pumps, each rated 440 gpm at 130 ft. TDH, complete with General Electric pump pressure controls, and two parallel 8,000-gal. capacity hydropneumatic tanks. Chlorination equipment was furnished by Wallace & Tiernan.

Contract for laying the water mains was let to the Inter-County Construction Co. of Fort Lauderdale, Fla. The wells were dug by the J. P. Carroll Well Drilling Co. of West Palm Beach, Fla. Consulting engineers for the town of Manalapan were Brockway, Weber & Brockway Engineers, Inc., of West Palm Beach. According to the engineers, the cost of material was slightly higher than for a usual operation of this type, but the total cost of installation, particularly the underwater portion, was substantially less than by the more conventional methods. Total project cost for the wells, pumps, storage tank, subsurface and subaqueous water mains, chlorination equipment and appurtenant work was approximately $150,000.

BIG WYE FOR HYPERION OUTFALL

THE LARGEST concrete pipeline wye structure ever installed at sea was recently placed in position nearly 200 feet below the surface approximately five miles from El Segundo, California. This structure is part of the ocean outfall of the City of Los Angeles Hyperion Treatment Plant. The wye marks the end of the 27,504 ft. of 144-in. i.d. reinforced concrete pressure pipe and the beginning of two 3,936-foot diffuser legs projecting out at 60-degree angles from the main line. Each leg starts with 102-in. pipe, reducing to 72-in. farther out, and has ports or openings spaced at 48-foot intervals in alternate sides of the pipe to diffuse the flow of effluent. The wye and concrete pipe were manufactured by United Concrete Pipe Corporation at its Long Beach plant. Measuring 41 ft. through the 144-in. pipe axis and 45 ft. across the legs, the wye is basically mortar lined and coated steel plate, the coating reinforced with heavy rod cages and the lining with wire mesh. The balance was gunited inside and out except for a vertical bulkhead structure which was poured in forms.

A 25-ton, box-like steel caisson with openings for the wye branches was assembled around the wye on the launching platform at United's Long Beach plant. When the assembly was completed, the launching platform was submerged with the wye, and a pontoon was floated into position. Then pontoon, wye and platform were raised out of the water. The wye was tied to the pontoon at one end and one 90-ton section of 144-in. pipe was tied to the other end to serve as a balancing block under the pontoon on the platform and as ballast when the tow was made out to the laying barge. The assembly was rested on a 4-foot bed of crushed rock, and the caisson was filled with rock into which packcrete was pumped from above to tie the assembly together into one massive structure of well over 500 tons. After a cleaning device is run through the 144-in. portion of the outfall, the concrete bulkhead will be inserted to close off the open end of 144-in. pipe beyond the legs of the wye.



● THE concrete wye structure, enclosed in a four-sided steel caisson.

BUILDING A YARDSTICK FOR POLLUTION CONTROL

THIS IS the story of pollution control development during the 1950's in a single river basin, the Yadkin, of North Carolina. Its significance centers in a dynamic state water pollution control program, concentrated utilization of good State and Federal laws, coupled with community action and citizen demand for clean waters. The Yadkin story may well serve to pilot other polluted river basins on the road to new economic progress.

The Yadkin River rises along the eastern edge of the Blue Ridge Mountains of northwestern North Carolina and flows northeastward for a hundred miles before bending to the southeast above Winston-Salem. Another hundred miles downstate, at the confluence of the Uwharrie, the Yadkin becomes the Pee Dee and flows on to the southeast through South Carolina to the Atlantic.

The greater portion of the Yadkin Basin, and that with which we are here concerned, covers 7,180 square miles in west-central North Carolina. On the map one sees it as a sloping diagonal touching Virginia on the north and South Carolina on the south, measuring roughly 245 miles north-south by 65 miles east-west. Place names there reflect the basin's history, geography, and land use from the days of Indian occupancy, white colonization, through the Civil War, to the present.

From the early days, people of the Yadkin Basin enjoyed an easy-going, good life. Mostly they were farmers. Fertile lands, large forests, abundant water supplied them well. There was fine hunting and fishing. They raised good crops of cotton, corn, tobacco, small grains and vegetables. As late as 1950, 58 percent of the 815,245 population resided in rural areas.

As in all America, the Yadkin Basin's population is growing. The pattern of living is changing. More than a million people now occupy the area. Light industry, principally textiles and plastics, are expanding there. Agriculture is losing its number one place as a means of livelihood.

As industry moved in and towns and cities grew, the Yadkin, like every other river basin in the land, by 1950 was faced with the inevitable problems of increased sewage and adequate waste disposal. The same streams that provided water for new industry and new people, became the recipients of the unwanted wastes of cities and factories. Their natural purification qualities no longer were adequate.

Enforcement provisions of the North Carolina law relating to stream sanitation can be applied to abate pollution only after a stream has been classified and a comprehensive pollution abatement plan adopted for the stream. In 1952 when the North Carolina Stream Sanitation Committee chose the Yadkin for its first such classification survey, the stream was neither the least polluted nor the most polluted in the State. A member of the committee explained, "We wanted to use it as a yardstick—an average polluted river used by both industry and municipalities."

Good laws often are hard won and such was the case in North Carolina's stream sanitation law. First introduced in 1947, and again in 1949, final passage in the state legislature did not come until 1951. A fledgling predecessor Stream Sanitation Committee of 1945 had never functioned because no funds were allocated. Nevertheless, it was credited with starting the ball rolling for the 1951 law "with teeth in it." Succeeding legislatures of 1953, 1955, 1957, and 1959 voted amendments and appropriations which added impetus.

Stream Classification

Field surveys in the Yadkin River Basin were conducted by the State Stream Sanitation Committee in 1952, and its survey report published in 1953. June 8, 1954, when the committee held its first public hearing to classify the waters of the basin, was aptly recorded "an historic day." Here was the fruition of a clean-streams movement some nine years in the making.

The Yadkin survey disclosed 66 points of significant pollution within the basin. From these an estimated 45 mgd of wastes were discharged. Domestic sewage made up 51 percent of the volume, while industry accounted for the other 49 percent. Some 52 percent of the wastes discharged to streams of the Yadkin Basin received no treatment whatsoever. There were 15 points discharging raw domestic sewage and 24 points discharging untreated industrial wastes. Existing treatment methods effected a 35 percent reduction of domestic sewage strength and only a 13.5 percent reduction of that of industrial wastes. Total overall waste load reduction by treatment was a scant 21.6 percent. Wastes discharged to streams of the Yadkin River Basin had an estimated population equivalent of 572,190.

Public hearings by the North Carolina Stream Sanitation Committee, prior to classifying the Yadkin Basin waters, brought out the usual protests: proposed waste treatment too expensive . . . not economically feasible . . . stream has served as waste carrier for 60 years, why change? . . . Fishing, swimming, and recreational uses not tantamount to industrial use and economic values . . . and so on.

But there were also many courageous citizens who testified: stream so polluted with dye that it always has a dark color, offensive odor . . . kills fish . . . if fish live, they are not fit to eat . . . cows died from drinking water . . . my best grazing lands ruined by poisonous overflow . . . land devalued 50 percent due to rotten odors and unfit waters . . . waters bare of all fish and wildlife where once plentiful.

Even as the public hearings and stream classifications progressed, some forward-looking cities and industries in the basin were beginning construction of waste treatment facilities.

VIRGINIA
Kernersville
High Point
Mount Airy
Pilot Mountain
Rural Hall
Winston-Salem
Lexington
Boonville
Yadkinville
Roaring Gap
Elkin
Jonesville
Mocksville
Cooleemee
Spencer
Salisbury
N. Wilkesboro
Wilkesboro
Statesville
Mooresville
Davidson
Londa
Mitchell River
Deep Creek
North Yadkin River
Middle Fork
Muddy Creek
Yadkin River
South Yadkin River
Fourth Creek
Third Creek
Irish Creek
Back Creek
East Creek
LEGEND :
Sources of Municipal Pollution
Sources of Municipal Pollution- Participating in Construction Grant Program
Sources of Municipal Pollution- Application for Construction Grant in State Office
YADKIN-PEE DE
NORTH CAROLINA -
Scale
10
0

Thomasville
Uharie
Little
River
Star
Biscoe
Candor
Troy
Denton
BADIN DAM
HIGH ROCK DAM
Badin
FALLS DAM
Mt. Gilead
Morrison
Creek
Ellerbe
Rochingham
Hamlet
Falling
Creek
BLEWETT FALLS DAM
Cordova
Cordova School
Granite Quarry
Albemarle
Rockwell
Norwood
Pee Dee River
Lilesville
Williams Mill
Jones Creek
Morks Creek
Mt. Pleasant
China Grove
Oakboro
Wadesboro
Morven
Goulds Fork
North Fork
South Fork
Mill Creek
Kannapolis
Concord
Buffalo Creek
Rocky River
Rocky Creek
Richardson Creek
Muggerhead Creek
Marshville
Long Brown Creek
Hunterstville
Wingate
Monroe
SOUTH CAROLINA
NORTH CAROLINA
DEE RIVER BASIN
A – SOUTH CAROLINA
le in Miles
10
20

The real start came, however, when the Federal Water Pollution Control Act of 1956 (Public Law 660) was activated, with its provisions for grants for the construction of sewage treatment works. Individual grants may go as high as 30 percent of the total estimated cost, or $250,000, whichever is smaller.

Federal Role

This program is administered jointly with the States by the Public Health Service's Division of Water Supply and Pollution Control. Applications for construction grants are submitted through the State water pollution control agency, which certifies to the Public Health Service that the project is entitled to priority on the basis of financial as well as water pollution control needs.

For the first three years after the construction grants became available (fiscal years 1957, 1958, 1959), North Carolina used approximately 20 percent of its total $3,804,050 grant allocation in the Yadkin Basin.

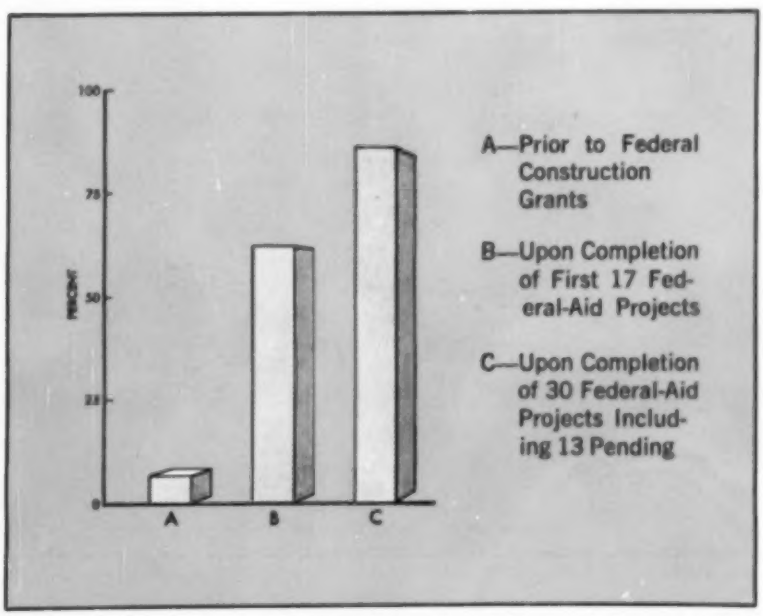
As of June 30, 1959, seventeen municipalities in the Yadkin River Basin have received Federal construction grants under Public Law 660 through the North Carolina State Stream Sanitation Committee. Thirteen others in the basin had applications pending. The 17 projects then under way had a total estimated cost of $13,507,332, and the grant offers amounted to $1,601,813. Approximately 150,000 persons or 56 percent of the sewered population in the Yadkin River Basin will be served by the 17 projects.

Among the first 17 projects are four for municipalities which previously discharged untreated domestic sewage to the streams. The other 13 in this group represent additions to, or improvements in, existing treatment facilities. Altogether the 17 projects will effect a reduction of 77 percent (population equivalent of 177,000) in the waste load previously discharged by these municipalities.

Typical Projects

Typical were projects undertaken by North Wilkesboro, High Point and Winston-Salem. The sewage treatment plant at North Wilkesboro is of the primary type having a designed capacity of 1.0 mgd. The units consist of a mechanically operated bar screen, grit removal facilities, a pumping station which houses the laboratory and control facilities, two primary settling tanks, an open sludge drying bed, and a covered and heated sludge digestion tank. This plant was designed by Piatt and Davis, Consulting Engineers.

The West Side Waste Treatment Plant at High Point involves secondary treatment, having a design capacity of 4.0 mgd. The units consist of comminution, grit removal, primary clarifiers, high rate roughing filter, tapered aeration, sec-



● **INFLUENCE of the Federal Water Pollution Control Program is demonstrated by this chart. The bars show how the percent of sewered population which has adequate treatment facilities has increased in the Yadkin Basin since enactment of PL 660.**

FOLD OUT — DO NOT TEAR

● **HIGH POINT West Side plant, typical of the newer installations, provides complete treatment by activated sludge.**

Courtesy N. C. Wildlife Resources Comm.

● **BADIN LAKE, one of the fine recreational areas in the Yadkin River Basin, benefits from improved pollution control.**

ondary clarifiers and chlorination with separate heated sludge digestion tanks. This plant was designed by William F. Freeman, Inc., Engineers.

The plant at Winston-Salem, N. C., was designed by Piatt and Davis and Associates. It is a high-rate trickling filter plant designed so that two of the four filters may be operated either in series or in parallel with the other two. Nominal design was based on removing 85 percent of the BOD from an average flow of 18 mgd having a BOD of 500 mg/L.

As a result of the construction projects, 218 miles of stream will be improved for uses including public and industrial water supplies, propagation of fish and wildlife, stock watering, irrigation and recreation. High Rock Lake, a hydropower impoundment on the lower Yadkin, is notably improved for fishing and recreation, according to the North Carolina Wildlife Resources Commission.

The Federal grants have been a definite stimulant in sewage treatment plant construction, not only in the Yadkin River Basin, but nationwide. At the end of November, 1959, Federal grant offers totaling $158 million had been made for more than 1900 sewage treatment plants in 50 States. Their total cost exceeds two-thirds of a billion dollars. Congress has appropriated $185 million during the first four years of the program — approximately $45 million per year.

Even now stream pollution remains such a problem that any gains of the fifties must be considered as an attack upon the backlog of sewage treatment needs. To wipe out the backlog and keep abreast of new pollution created by new growth, some $575 million must be spent during each of the next five to eight years for municipal sewage treatment plants. A similar outlay of funds by industry is indicated to abate the present and potential discharge of factory wastes into the nation's streams.

A requirement of the Federal Water Pollution Control Act that the municipality receiving grant funds shall provide adequate operation and maintenance, has been a further favorable influence to reduce pollutional discharges to streams.

The substantial number of applications for sewage treatment plant construction grants now being prepared by municipalities in the Yadkin River Basin is further evidence that Public Law 660 has helped to accelerate these much needed facilities. Other municipalities and industries within the Basin have installed abatement facilities without Federal aid.

Local Reaction

The total impact of these installations is beyond the conjecture stage. Results are showing. Attitudes are changing. A before-and-after analyzation of waste treatment by cities receiving Federal aid is presented in the accompanying chart. One gets the feel of public acceptance and progress from this recent editorial in the *Winston-Salem Journal*, a leading newspaper of the Yadkin Basin:

"The stream sanitation body has had remarkable success in getting communities and industries to set up or improve waste treatment facilities.

"In this area the committee has met with a very high measure of voluntary cooperation from municipalities and enterprises having sewage wastes to dispose of. The clean-up program is necessarily a gradual one. Time, effort, and expense are involved. Municipalities must make studies, hold elections on bond issues, and so on.

"Smaller industrial plants may find it difficult financially to construct treatment plants of their own. Local units of corporations operating over a wide area may have to get projects cleared by their national headquarters. In many cases cooperation of municipalities with local industries may be required.

"All this takes time. The important thing is steady if gradual progress toward the desired objective.

"In the light of these conditions, the patient persuasion policy of the stream sanitation committee seems justified. It also is justified, apparently, by its results. The fact that the committee is achieving results without using the law to compel compliance doesn't mean it won't use the law when necessary. Knowledge of this fact is perhaps one of the most effective spurs toward voluntary compliance. Another spur to municipalities is the federal aid program in financing better sewage treatment facilities."

The waters of the Yadkin River Basin have not been, nor are they presently, used to their utmost. There is an adequate quantity, both ground and surface, to sustain extensive additional industrial expansion, population growth, recreation development, and other legitimate uses, provided the comprehensive water pollution control program is carried on to completion.

In selecting this river basin for the first of its comprehensive river basin pollution control projects, the North Carolina Stream Sanitation Committee got its "Yadkin Yardstick." And who can say that it is not an effective yardstick for all America?

ANOTHER COUNTY OPERATES A SANITARY LANDFILL

PAT THOMSON,
County Engineer,
Douglas County,
Waterville, Washington

IN A RECENT convention of the Washington State Association of County Commissioners and Engineers, a panel of businessmen had been invited to discuss the role and standing of county government with the business public. In this discussion it came out that most of the businessmen on the panel considered county government to be archaic, a vehicle still operating under 1920 conditions. And it was also apparent that however intelligent these men may be, however successful in their private businesses, they did not have the slightest idea of the functions of county government in this period of huge urban development nor of the legislative impositions under which it must operate. These businessmen did not realize that county governments are now virtually public works departments, supplying all the modern functions of good living standards. Douglas County, as the fourth fastest growing region in the Pacific Northwest, has had a tremendous suburban growth.

Douglas County, Washington, lies nestled against the foothills of the Cascade Mountain Range. From the gentle rolling slopes of the Columbia River valley, once occupied by soft fruit and apple orchards, there is a perfect view of the jagged snow capped peaks of the Cascade Range. People began moving from the Chelan side of the river to our area mostly because they wanted more acreage and the magnificent view. Then came the construction of two major hydroelectric dams with the resultant multimillion dollar highway and railroad relocation. Newcomers wanted to build on the slopes and building permits jumped to $3 to $4 million yearly. Houses were being constructed in blocks of twenty and thirty at a time. Land that sold for fifty dollars per acre suddenly became worth $2000 per 100-foot lot. This boom has continued unabated for almost ten years. Roads that used to carry about 50 orchard trucks per day are now widened and are bearing up to 10,000 vehicles daily. The area has become one of the fast growing suburban developments, with no apparent limit to its expansion.

In the growing pains of such a development, it always appears that some items get out of hand. Our garbage disposal system was something like Topsy, it more or less grew with the need without an organized plan. The county had a 40-acre tract, relatively near the residential section, that contained a large canyon which seemed ideal. With a little work, we constructed a road along the bank and our open pit method of disposal was underway. At first, this did not offer too many problems, for people seemed to be willing to cooperate without hiring a dump supervisor. However, as the population increased, we began to acquire old washing machine bodies, electric stoves, car bodies and innumerable stumps and brushpiles from orchards being removed and platted into lots. Soon it became almost impossible to compact the material, and during the hot weather, with no control, we could not burn the refuse due to the incendiary character of the neighboring land.

Then it happened. Someone spotted the first rat. Actually, he was a scrawny, puny-looking sort of a rat, nothing really to get excited about. But he must have been more of a rat than we figured, for he soon had 10,000 offspring. They peeped from every can and rustled through every opening in their endless search for succulent garbage tidbits. But as long as they confined their activities to the dump ground, no one seemed to worry or to care a great deal. With the open pit dump remaining, the health department gave up trying to eliminate the rats by poisoning. But the rats multiplied themselves out of house and food, so the hardier ones went foraging. And when Madam Housewife opened her kitchen door to find

● **CARRYALL** in rear covers open pit area. In foreground Chairman McLandress and Myron Gormley inspect fill operation.

● **TRACTOR** and carryall are opening a ditch for sanitary landfill operations. Dirt will be used to cover the old dump.

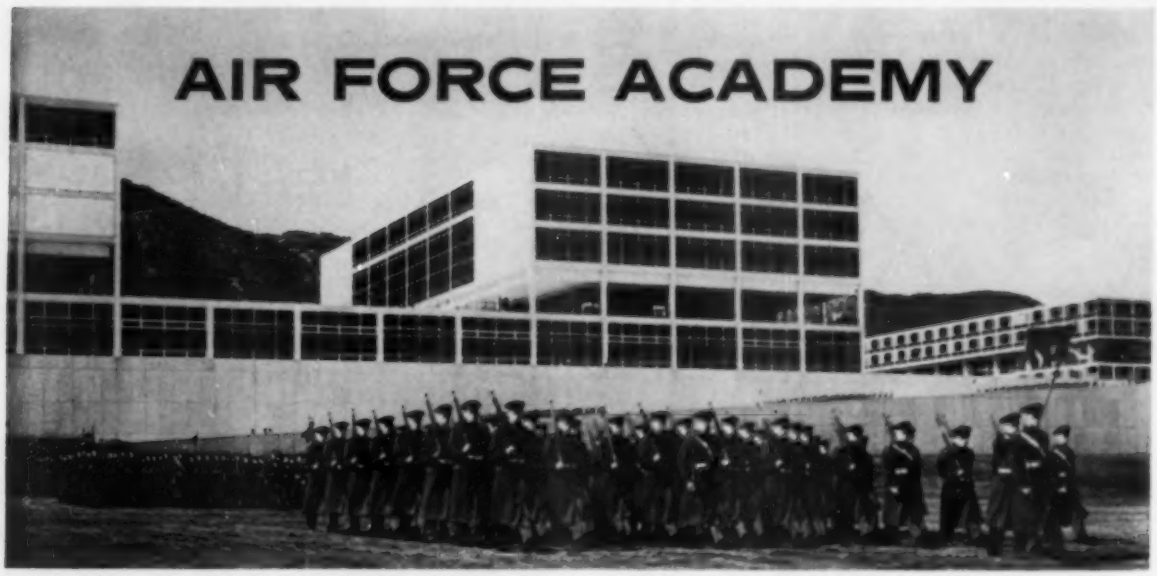
Friend Rat by her garbage can, her screaming echoed clear to the office of the Board of County Commissioners.

Even the most cursory of inspections revealed that something had to be done. We needed first to consider our factors of disposal. It was evident that we would have three types of material to contend with—the residential garbage, the fruit farm brush and stumpage and the commercial disposal of larger metal units. We must also consider that our population could easily double or triple in the next ten years, and that our disposal area must be large enough to handle this increased material. The land that we now owned lay in a relatively flat crescent around the canyon used for open pit dumping. It presented an ideal topography for the installation of a sanitary landfill type of construction. It was close enough to the expanding residential district so that people could haul individually and that contract garbage disposal would not be overly costly. It was large enough to allow the expansion needed for our growth. And it could be reached by an arterial road that did not require the disposal units to travel through the residential neighborhood.

Constructing the Fill

Being a heavy clay, the soil was ideal for the trench method of sanitary fill for the banks would stand on a vertical cut. Using a carry-all and a D7 Caterpillar tractor, we constructed a trench some 300 feet long and ten feet deep. Meanwhile,

(*Continued on page* 208)



INSTALLS NON-POTABLE SYSTEM FOR IRRIGATION

ON NEARLY 18,000 acres of ranch land at the foot of the Rampart Range of the Rocky Mountains, the Air Force has built an institution of higher learning and, necessarily, a city to support it. The first class that graduated from the Academy numbered only 207, but by 1962, the Cadet Wing should reach authorized strength of 2,550 men. Faculty, housekeeping, and support personnel, many with families, will swell the population to an estimated 10,000.

The elevation of the site varies from 6,325 to 8,160 feet and annual precipitation averages only 17.5 inches. This has its advantages, affording excellent weather for outdoor drill and instruction and approximately 330 days a year suitable for flying. But the dry climate increases water requirements and makes more difficult the provision of an adequate supply.

The City of Colorado Springs agreed to furnish up to 5 mgd from its sources across the Rampart Range. This was deemed sufficient for the potable water needs of the "academy-city."

Blue grass turf was specified for athletic fields, parade grounds, and recreational areas. Also, there would be lawns and other plantings around Academy buildings and residences, and grass on roadway medians and side slopes. Colorado's sparse natural rainfall would not be adequate for maintenance of this turf and irrigation would be necessary through most of the growing season. Further, the irrigation water supply would have to be adequate to support the turf during protracted periods of drought. With blue grass requiring 1.5 to 2 inches of water per week during the growing season and native grasses needing 1 inch a week, the total water needs for domestic and irrigation use would be roughly double the volume provided by Colorado Springs.

Groundwater Sources

Natural surface flow on the site could not be used to make up the differential for state law enjoins the Academy from impounding this water. But surveys and test borings

● ONE OF the three reservoirs in the non-potable system. These are filled when irrigation demands are low to provide 120 million gallons during the drier months.

showed that water was available if the Academy would dig for it. In the Dawson Arkose formation, 300 to 800 ft. below the surface, was a considerable quantity of potable water. The Fox Hill formation, about 700 to 1100 ft. down, also showed volume worth exploitation but excessive mineral content made the water unpalatable.

Eight deep wells were put in service, six extending into the Dawson Arkose and two into the Fox Hill formations. Deepest well is No. 1, drilled to a depth of 1,065 ft., into the Fox Hill aquifer. The Fairbanks-Morse 6-in. oil-lubricated vertical turbine pump serving this well has a 54-stage bowl assembly and is driven at 1760 rpm by a 40-hp Fairbanks-Morse vertical hollow-shaft motor. Its capacity is 125 gpm at a 680 ft. head.

Typical of the Dawson-Arkose wells is No. 4a which was drilled to a depth of 657 ft. The 8-in. oil-lubricated F-M turbine pump at this well has a 27-stage bowl assembly and is driven at 1760 rpm by a 75-hp F-M hollow-shaft induction motor, delivering 300 gpm at a 700-ft. tdh.

With an operating schedule of 20 hours a day, 7 days a week, the 8 wells can yield about 1800 gpm for a total of 15.12 million gallons a week. But this still would not be adequate. Another source of irrigation water is the effluent from the Academy's sewage treatment plant. The complete treatment at this new plant provides an effluent sufficiently pure for irrigation use. Since water requirements were figured on the basis of eventual population, it was logical to calculate effluent volume the same way. On this basis, there would be 5.6 million gallons available each week.

It was decided to use the Colorado Springs potable water for all domestic needs and for irrigation of lawns and shrubs near academy buildings and residences. The potable Dawson-Arkose water, and the non-potable Fox Hill water, and the sewage effluent would all be combined in a separate non-potable water system and used exclusively for irrigation of athletic fields, parade grounds, recreational areas, and road medians and side slopes, a total area of 712 acres. Total eventual water requirement is calculated at about 30 million gallons a week or 5 mg a day, applied 6 days a week.

To meet the 30 mg a week demand, the Academy had 7-day production totals of 15.12 mg from the wells and 5.6 mg of effluent, leaving a deficit of 9.28 mg for a week of drought. Since the supply of well water and effluent would continue during the dormant season, it was decided to provide storage facilities which could be filled in the off-season and utilized to augment the short water supply during dry summer months. Three reservoirs were constructed with a combined usable capacity of 120 million gallons. This would permit irrigation at the maximum anticipated rate for a period of 90 days.

To handle the gathering, storage, and distribution of irrigation water, an elaborate system was devised. Included are six pumping stations with an aggregate of 14 F-M pumps, the three reservoirs, pressure control valves, 85 miles of pipeline, permanent underground irrigation grids, and portable grids for connection to 198 hydrants spaced at 1,000-ft. intervals along the primary roads. The hilly terrain causes considerable variation in pressure and the operators tolerate a maximum main pressure of 240 psig in the low areas in order to maintain a minimum of 80 psig at maximum elevation.

Distribution Facilities

Major facilities are divided into four sub-systems. The largest volume of water originates with Subsystem No. 1 which includes six wells and the effluent supply. Water from two wells and the sewage treatment plant effluent flow into the sump of Pumping Station No. 4 where it is picked up by one or more of four F-M vertical turbine pumps. Operation of the pumps is controlled automatically by water level in the sump. All deep well pumps in the entire system are controlled by program timers, but in the case of the two wells that discharge into Station No. 4, a float control in the station sump overrides the timer, shutting down the well pumps if sump level is too high. In all stations, manual controls can supersede the automatic controls. The sump elevation at No. 4 is arranged so that an excess of water in the sump will first halt, then reverse flow in the line from the treatment plant chlorine contact chamber, and effluent will overflow from this chamber into Monument Creek.

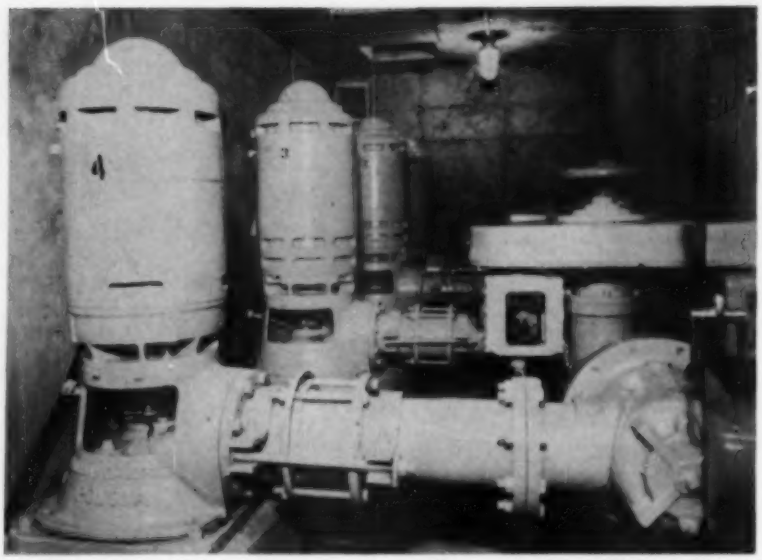
The four pumps at Station No. 4 discharge through motorized cone valves which open or close in about a minute after the pumps are turned on or off. From the station, water goes to a main extending about 4.5 miles from the Academy North entrance to Reservoir No. 1, providing for irrigation of the entrance area and road medians and side slopes. Two additional well pumps discharge directly into this main.

An important element of the subsystem is a pressure control point on the main before it reaches the reservoir. When pressure in the main exceeds a predetermined level, the control valve opens automatically and permits water to flow into the reservoir, closing again as main pressure drops. The setting, of course, is high enough to maintain at all times the pressure required for irrigation. Two more wells complete this sub-system: one discharging into the main on the reservoir side of the pressure control point,

the other through a separate supply main directly into the reservoir.

Sub-system No. 2 uses water from Reservoir No. 1 augmented by two deep wells to supply mains extending north along the dual road and then east to the Academy's north entrance. Excess supply is delivered through another pressure control point to Reservoir No. 2. The main pumping station for this sub-system has two pairs of F-M horizontal split-case centrifugal pumps with each pair operating in series to deliver 1400 gpm at a 400-ft. head using a common suction line and a common discharge pipe. Electric time switch controls automatically start and stop pump operation in accordance with daily schedules set for a seven-day cycle. Superseding this schedule, high-low level controls automatically stop both pump units when water level in Reservoir No. 1 (the suction pool) drops to Elevation 6550, or if Reservoir No. 2 (the discharge pool) rises to Elev. 6895. Manually-operated switches can be used to override both the program and level controls.

Sub-system No. 3 draws water from Reservoir No. 2 and pumps it through three irrigation supply mains, delivering the excess up the hill to Reservoir No. 3. In this pumping station, unlike the others, each pump has a separate function and operates independently. All three pumps are F-M horizontal split-case centrifugals and all take suction from a common supply line. A 6-in. pump discharges into a line with one branch going to Reservoir No. 3 and another along a road to irrigation grids in the Academy cemetery. The pump provides the pressure required at the sprinkler heads, and all water not drawn from the line for irrigation is lifted to the reservoir. An electric timer starts and stops the pump in accordance with a preset seven-day schedule. This can be overridden, however, by a high-low level control which shuts down the pump if Reservoir No. 2 level drops to Elev. 6860 or Reservoir No. 3 level rises to Elev. 6960.

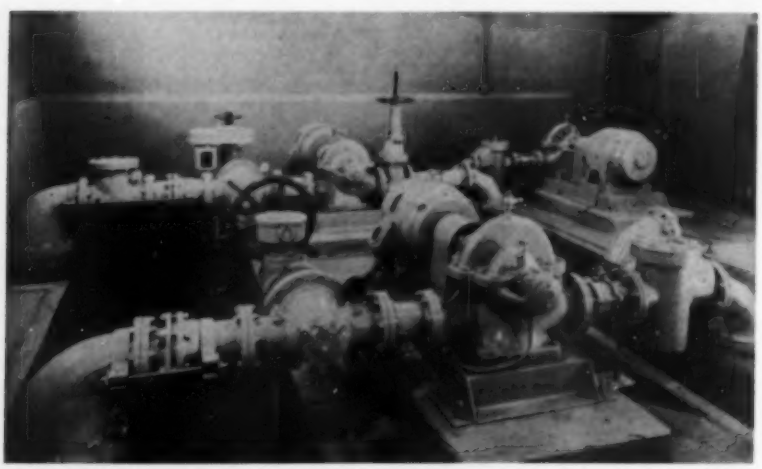


● **FOUR pumps in this underground station deliver sewage plant effluent and well water to irrigation system. Pumps are F-M; capacity totals 1350 gpm at 300-ft head.**

Each of the other two pumps has a separate discharge line serving a recreational area. Manual controls are used to start and stop these units.

Finally, Sub-system No. 4 handles a heavy irrigation load, supplying the grids for the cadet athletic fields and the parade grounds as well as distribution mains with hydrants along major sections of several primary roads. Also, make-up water is pumped up to Goat Camp Pond, an artificial pond constructed for aesthetic reasons. The main pumping station (like the one described for Sub-system No. 2) has three series-connected pairs of F-M horizontal split-case centrifugals. In this case, each dual unit is rated at 1400 gpm at a 375-ft. head. All water is drawn from Reservoir No. 3 through a common supply line and all the pumps discharge to a common header. A cone valve on the discharge and a gate valve on the suction side of each pump make it possible to isolate one pump while the others are at work. The pumps are remote-controlled from the Academic Building and IBM dual coded relays are provided for each unit. To push water to the highest irrigation sections in the system, a pair of underground booster stations have been provided. Both have single F-M centrifugal pumps, one with a capacity of 625 gpm at a 120-ft. head, the other with a rating of 625 gpm at a 90-ft. head. The first has the added function of supplying water to Goat Camp Pond. Electric program timers control these boosters and additional controls insure that the pumps will not operate when the main pump station is shut down.

The system was designed by Skidmore, Owings & Merrill of Chicago in association with Robert & Company Associates of Atlanta, with the cooperation of the Air Force Academy Construction Agency's civil engineering staff headed by E. C. Lendenmann.



● **THESE three pumps draw water from a common main, but have separate functions. One supplies roadside areas and cemetery; others pump to recreation areas.**

BALTIMORE COUNTY

ESTABLISHES URBAN HIGHWAY SYSTEM IN RURAL AREAS

ALBERT B. KALTENBACH,
Director,
Baltimore County
Department of Public Works,
Towson, Maryland

IMAGINE placing a community with a population approximating that of Syracuse, New York; Omaha, Nebraska; or Jacksonville, Florida in an essentially rural area in just one decade. That summarizes what has happened in Baltimore County, Maryland's most heavily inhabited county. The official 1950 census listed Baltimore County's population as 270,000. The unofficial count as of June, 1959 was 493,000, and County statisticians are firmly convinced that the 1960 census will reveal a figure well in excess of 500,000 residents. This rate of increase greatly exceeds the national average, and places Baltimore County among the nation's leaders in the rate of residential growth. This growth will no doubt continue.

There are many factors that have contributed to the phenomenal population growth in Baltimore County during the 1950's and these same fundamentals indicate a continuance of this rate of growth in the future. The large industrial firms such as Bethlehem Steel, Martin Company, Black and Decker, and Bendix Aviation have invested millions of dollars in expanding existing plant facilities, thereby creating new employment opportunities. New industries have moved into the County, being attracted by the excellent waterfront, rail, highway, and air facilities, the proximity to broad markets, and the availability of strategically located large, uncrowded industrial sites. Baltimore County has been the recipient of many former urban dwellers who have joined the general exodus from the City. Increased birth rate has been a contributing factor. Office buildings, including the huge new Social Security Building, along with other commercial type development have also attracted new residents.

Geographically, Baltimore County completely surrounds the trapezoid-shaped periphery of Baltimore City, excepting a short segment along the City's southern boundary. The County extends north of Baltimore City's northern boundary about 24 miles to the parallel Mason-Dixon Line, Pennsylvania's southern border. From its most easterly land point on the Chesapeake Bay, it extends approximately 30 miles due west at its widest point. It has 610 square miles within its boundaries. By far the major land area in the County is still rural with truck and dairy farms occupying the largest portion of the gently rolling countryside. The southeastern section has the deep water port facilities and the heavy industrial complexes, including Bethlehem Steel's gigantic Sparrows Point facilities. Other industries and zoned industrial sites are located north and south of the City along main highway and rail routes. Residential development has taken place around the entire perimeter of Baltimore City, and is reaching out into the County in an ever expanding circle. Unincorporated communities like Lansdowne, Catonsville, Woodlawn, Pikesville, Rogers Forge, Towson, Parkville, Essex, Dundalk and Sparrows Point now form a continuous residential belt about Baltimore City.

The rapid growth and development in the County occurring during the past decade and still continuing unabated has created an unprecedented and seemingly endless demand for roads of all types. The Baltimore County Department of Public Works, established in 1948, is responsible for the construction and maintenance of the County road system. The Department of Public Works is also responsible for many other services including water supply, sewerage, storm drainage,

building construction and sanitation. The Department's role becomes increasingly important since no municipalities exist, the County providing all local government and services. No attempt will be made to elaborate on the other functions, since this article deals with the highway, street and road system.

Planning

The continued development extending further out the radial routes, and filling in the land between these highways, as it progresses, has created the need for extensive planning by Baltimore County itself, and close coordination with the City of Baltimore, Maryland State Roads Commission, and the four adjoining counties. For some years the County has had an effective Office of Planning, the functions of which include the development of the Land Use and Master Street Plans. This planning and coordination has assisted the State Roads Commission to proceed rapidly to widen, resurface, and generally rehabilitate many miles of existing primary and secondary state roads, and to build several new ones in the county. The Baltimore Beltway is an example of effective planning as it was originally conceived by County officials as a means of connecting the many populous communities in a circular route. The State Roads Commission adapted this plan, along with one of their own, for getting around Baltimore City. The Beltway thus became a part of the Interstate System for through traffic and will also serve the County as an intercommunity highway. The City of Baltimore has plans for several express-type highways, which again require careful City-County coordination for the most effective ultimate results. The Land Use and Master Street Plans have enabled the County to locate present and future sources of traffic congestion, and thereby undertake constructive measures. County expressways such as the Towson Belt Route, Merritt Boulevard, and Security Boulevard already have resulted in moving and dispersing traffic faster, in promoting safer driving conditions, and in opening the upland for all types of development.

County Highways

There are 2,091 miles of road in the County, of which 346 miles are State Highways and 1,745 miles are the property and responsibility of Baltimore County. The older main State routes, most of which have been widened and resurfaced, have unlimited access, and while they are through traffic highways, they serve the County as collector type streets. Average daily traffic on these roads varies from 10,000 to 35,000. Dual expressways with controlled access are being built by the State Roads Commission. These serve through traffic as fast moving high speed routes, and with good interchange spacing serve local purposes as well. The State secondary routes in the County, with several exceptions, are in the rural areas and carry relatively low, but steadily increasing, traffic volumes.

● **ONE OF the County Expressways, Security Boulevard, will carry about 6,000 vehicles daily. It has two 34-ft. pavement lanes, with 12-ft. median, on 120 ft. ROW.**

Basically, Baltimore County's approximately 1,800 miles of roads are classified as rural, neighborhood, and collector. Considerable attention is being given to all three types, and road building activity is in evidence over the entire County. The rural roads have not been neglected, as the Bureau of Highways has widened, improved alignment, and hard surfaced many miles of these roads, as well as having performed their maintenance functions. Necessity, however, dictates concentration of effort in the rapidly developing areas close to, and spreading out from Baltimore. The construction of neighborhood streets, along with their many utility problems, and the building of collector type streets, is proceeding in an orderly manner.

Subdivision Streets

About 45 miles of subdivision streets have been built each year in the County over the past five years. These neighborhood streets have been constructed in all types of subdivisions ranging from apartment houses and row houses to detached residences on 40,000-sq. ft. properties. The influx of from 6,000 to 7,000 residential units per year, with the attendant demand for water, sewerage, drainage and roads have required strong County subdivision regulations. In order to protect the new or prospective home owner, the home owner of longer standing, and the County itself, the need for effective regulations were recognized some years ago. Policies and regulations for present road, street, and drainage construction were adopted in 1953 and 1956, and established the County's and the developer's responsibilities for financial obligations, engineering design and standards, rights of way dedication, and construction and inspection procedure. Residential developers pay the entire cost of the street and are assessed storm drainage costs on a front foot basis. Industrial, commercial, and apartment developers pay the entire cost of streets and drainage.

The Bureau of Engineering of the County Department of Public Works administers these regulations from plan review through the final acceptance of the road into the County system. Developers submit engineering drawings prepared by consulting engineering firms to the Bureau for their review as to conformance to regulations and design standards. Once plans are approved and accepted and financial obligations met, the Bureau's Contract Division advertises, receives bids, and processes contracts for subdivision street construction. The Inspection Division of the Bureau of Engineering is responsible in seeing that these road construction contracts

are fulfilled in compliance with the plans and specifications.

Streets serving apartments and groups of houses and collector type streets have 60-ft. wide rights of way, 36-ft. wide macadam pavements, and concrete curb and gutter and sidewalks. New streets in 6,000 to 10,000-sq. ft. property areas have the same standards as above except that 50-ft. rights of way and 30-ft. wide macadam pavements are required. Less populated areas require 50-ft. rights of way, 18 to 24-ft. wide macadam pavements, and some bituminous curb. Rights of way are deeded to the County. The macadam pavement section consists of a 2-in. sub-base, 5-in. dust bound macadam base, 3-in. asphalt penetration course, and a triple asphalt surface treatment wearing course. If soil conditions indicate the need for additional pavement thickness, it is obtained by adding sub-base material.

Primary County Roads

The County primary system is designed to connect the several communities and to provide efficient transportation between them. These collector roads accumulate traffic from a few small neighborhoods in some instances, and entire large communities in other cases. Residential areas are connected to commercial and industrial areas by roads in this classification. Critical traffic congestion in several population centers is being alleviated by constructing this type of road. Since the primary system varies in its functions and intensity of use, the individual roads vary in appearance.

As development progresses into the rural area, it eventually follows the existing county roads. There are many miles of these roads that are now serving as busy collector streets. Safety has necessitated improvement in these facilities. Where residential, commercial, and industrial building have taken place directly along these routes, the developer shares in the improvement costs. By utilizing the existing road bed, and having developers contribute widening strips, curb and gutter, and drainage costs, Baltimore County receives a major improvement very economically. Depending on location and type of development, such roads are made 30 to 48 ft. wide.

Bituminous concrete has been used to improve a considerable mileage of roads in the more heavily traveled sections. In most instances, a relatively thin course of bituminous concrete is placed over the old surface. This improves the riding qualities by removing the many small irregularities in the existing road. Long depressions and deeper settlements are corrected separately using the same type of material. The surface and wearing course also helps eliminate some of the high crowns prevalent in older roads. The wearing surface provided by this course presents an attractive appearance, produces a smooth ride, is practically self-cleaning, decreases maintenance costs, and extends the pavement life indefinitely. It has proven economical to place and to maintain. An allotment of $500,000 has been requested in the 1960 operations budget to resurface streets with bituminous concrete.

● **WISE AVE., another of the County Expressways, is also a part of the Capital Improvement program. The 48-ft. wide pavement carries some 13,600 vehicles daily.**

County Expressways

During 1959, the Department of Public Works had seven contracts for more than 9 miles of expressways aggregating $3 million in various stages of construction. Five of these thoroughfares are on new rights of way, while two utilize existing rights of way and road beds. A total of 4 contracts, including those for Merritt Boulevard, Wise Avenue, and Delvale Avenue are southeast of the City. The other three include Goucher Boulevard which is north of the City, and Security Boulevard and Edmondson Avenue which are to the southwest. Roads on the new locations connect existing primary roads, while the rehabilitated ones generally radiate out from the City. The seven County primary roads presently under construction fulfill all of the purposes of this type of highway and will offer immediate traffic relief upon completion. These County expressways have average daily traffic and other statistics as follows:

Wise Avenue—with a 48-ft. wide pavement, curb to curb, on a 60-ft. right of way—has a traffic load of 13,600.

Merritt Boulevard—two 24-ft. pavements and a 24-ft. grass median on a 120-ft. right of way—handles 15,000.

Delvale Avenue—with a 48-ft. pavement curb to curb on an 80-ft. right of way—handles 5,000.

Goucher Boulevard—two 36-ft. pavements and a 16-ft. median on a 110-ft. right of way—has a load of 10,000.

Edmondson Avenue—a 48-ft. pavement curb to curb on a 60-ft. right of way—handles 12,000.

Security Boulevard—two 34-ft. pavements with a 12-ft. median on a 120-ft. right of way—has a load of 6,000.

These highways are part of the County capital improvement program. The necessary funds for engineering, land acquisition and construction are obtained from County highway construction bonds, Federal aid urban and secondary funds, State Roads Commission county highway construction bonds, and other general taxes.

The Design Division of the Bureau of Engineering is responsible for the preparation of plans and specifications for these county expressways. Extensive use is also made of consulting engineers in performing these services, in which case the Design Division schedules, reviews, and recommends for approval the construction plans. An important objective of the design criteria and standards is to build

the routes in such a manner that the roads will handle traffic efficiently for many years in the future. Adequate pavement widths, wide medians, storage lanes, lighting, minimum traffic signals, curb and gutter, service roads, proper drainage, and adequate rights of way represent the means of reaching this objective. The Baltimore County Department of Public Works has adopted its own design standards and a Standard Design Manual is followed in public works construction. These are discussed in detail in an article appearing in PUBLIC WORKS, April, 1956, entitled "Standardization of Utility Design Procedures," by A. R. Vollmer and J. G. Peeler, Jr.

Rights of way are acquired by the Bureau of Land Acquisition of the Department of Public Works. The County has power to condemn properties for highway purposes, but does not have prior entry rights. Consequently, before any highway contracts are let, title to necessary land must be acquired.

Soils in Baltimore County can be grouped in three classifications for the most part. Silty clays, highly micaceous, in the A-5 Group predominate. Silts classified as A-4 material are abundant. Some A-3 sandy material is also encountered. Supporting abilities of these soils range from the lowest to the highest value in their classifications. Changes in bearing value can be abrupt, and soils within short distances offer poor to good supporting abilities. Run of the bank material suitable for improved subgrade, sub-base, and base courses are available in good supply in certain areas. Crushed limestone rock with excellent cementing qualities is present in abundance. Slag from the steel furnaces at Sparrows Point is also utilized as pavement aggregate.

Flexible type pavements are used extensively for the County expressways. Most of the pavements constructed during 1959 had 15½-in. pavement sections, including sub-base. Present sections include 4-in. Type II sub-base (bank run gravel or crusher run stone), 8-in. dust bound macadam placed in two courses, 2-in. bituminous concrete binder course, and a 1½-in. bituminous concrete wearing surface. If sub-grade conditions indicate the need for additional pavement thickness, it is obtained by using an A-3 or better borrow material, if available, or by increasing the depth of the Type II sub-base material. That these pavements have proven economical to build is evidenced by the 1959 average in place cost of less than $3.75 per square yard. Sections of Merritt Boulevard, Fairmont Avenue, Bosley Avenue, and Edmondson Avenue, which were opened to heavy traffic as early as 1954, are durable and economical to maintain.

● AN OLD County road 18 ft. wide, Smith Ave., is being converted into collector type street 36 ft. wide. Developers paid the major portion of widening costs.

● OUT AT the end of the old street car line, Edmondson Avenue is scheduled for conversion this year to a 48-ft. urban street, utilizing old road and car line ROW.

Edmondson and Wise Avenues represent major improvements which utilized existing facilities to the best possible economic advantage. Both thoroughfares carry large amounts of traffic, and since Wise Avenue leads directly to the Baltimore Harbor Tunnel Thruway, it carries a large volume of heavy trucks. The new 48-ft. pavements were obtained by widening the existing 18 to 20-ft. roads on one or both sides, and utilizing the road metal already in place as a base. Bituminous concrete wedge and leveling courses are used to establish the old road to proper cross section and profile grade. Widened areas are brought flush with the old road with 12-in. of macadam and sub-base and topped with a 2-in. bituminous concrete binder course. The entire 48-ft. width is then surfaced with a bituminous concrete wearing course. Traffic must be maintained at all times during the construction period. The hard surfaced old road serves as a detour during the construction operations, thereby eliminating the need for building costly detours.

While there are many miles of subdivision streets to build, old roads to adapt and to rehabilitate for present day use, and new expressways to construct, the problems for orderly growth for the most part have been resolved. The tools offered by farsighted planning and sound engineering are enabling those responsible in Baltimore County to bring a new system into a rural area in an organized manner.

OAK PARK IS READY FOR SNOW

FRANK R. SMILEY
Assistant to the Village Manager, Oak Park, Illinois

DURING 1959 preparations for snow and ice control in this community of 63,000 were improved significantly. One of the more conspicuous changes has been the addition of a passenger bus to the equipment used for salting.

For new ideas on salting we visited our local bus company and talked with the management at the Chicago Transit Authority. Both showed us buses which they had converted to salt spreaders which were quite satisfactory for their needs but not for us. We wanted a quick-loading, continuous spreading unit capable of handling bulk salt.

For $250 we purchased a bus from the West Towns Bus Company, a suburban transit company located in Oak Park. Then we started remodeling the inside. The completed salt bus is tailor-made for our needs. A 10-foot long "door" in the roof permits us to use either our Hough Payloader or the Tractomotive front end loader to dump bulk salt into a built-in hopper which holds over 10,000 lbs. The aluminum-clad hopper floor is sufficiently elevated and sloped to feed the salt into a Tarrant Scotchman spreader mounted inside the bus at the rear end. No bulky unit hangs outside the bus and an outside spotlight illuminates the spreading.

With the mechanical problems out of the way, we painted the entire bus a two-tone white and orange color with prominent lettering telling one and all that this brightly painted vehicle is for snow and ice control in the Village of Oak Park.

The final step was to reorganize our salt routes, assigning the bus to the long, wide streets and boulevards and leaving the difficult areas to the more maneuverable salt-spreader trucks.

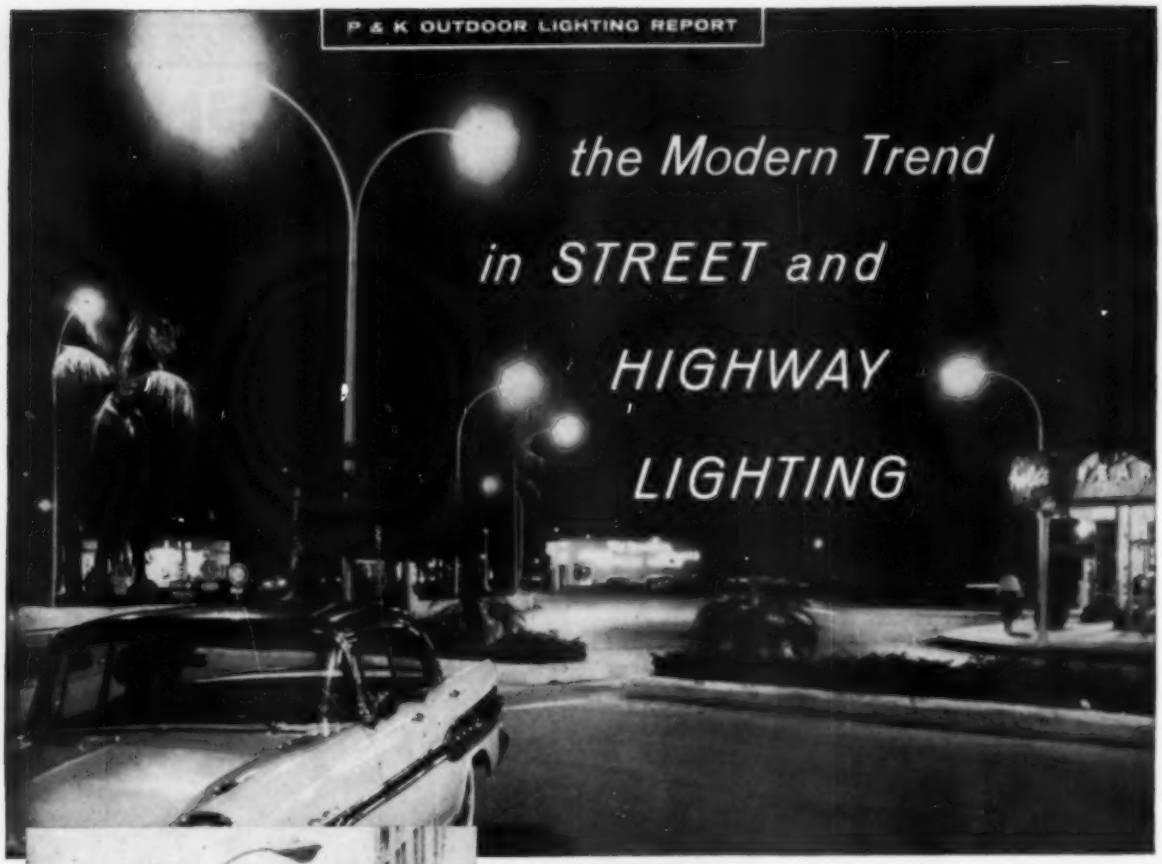
Completion of our salt bus is only one of several aspects of snow-fighting which we improved during 1959. Other new approaches included the following:

1. Full utilization of contract forces for loading and hauling snow in the major business districts.
2. A shift from bagged salt to bulk.
3. Preparation of a pamphlet entitled "Snow and Ice Control Procedures for the Village of Oak Park".
4. Assignment of sidewalk plowing responsibility to the Forestry Division.
5. Cooperation from the Cook County Forest Preserve to provide disposal areas for snow.

● **LOADER is shown filling bins of bus with salt through 10-ft. long door cut into roof. Bins will hold more than 10,000 pounds of salt. Floor is aluminum-clad.**

● **BINS ARE elevated and sloped so as to feed salt into Scotchman spreader inside and at rear of bus. Unit is used on long, wide streets and boulevards, with few turns.**

P & K OUTDOOR LIGHTING REPORT



TOP PHOTO: Traffic circle illumination — West Miami Springs, Florida

LOWER PHOTO: New White Way — White Plains, New York

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NEWS BULLETINS

AMERICAN PUBLIC WORKS ASSOCIATION, 1313 EAST 60th STREET, CHICAGO 37, ILLINOIS

Screvane Named General Chairman 1960 Congress and Equipment Show

The 1960 Public Works Congress and Equipment Show, scheduled for the New York Coliseum, August 14-17, is destined to be one of the major events of the year for public works officials. APWA President Jean L. Vincenz recently named Paul R. Screvane, Commissioner, Department of Sanitation of New York City, as General Chairman of the 1960 Congress and Equipment Show and also announced that the Hon. Robert F. Wagner, Mayor of the host city, will serve as Honorary Chairman of the New York meeting.

The APWA's Public Works Congress and Equipment Show serves the entire public works field by bringing together "key" officials—chief administrators, commissioners, directors of public works, city engineers, superintendents of streets, water, sewage disposal and sanitation systems and other governmental officials from all parts of the United States and Canada to exchange views on public works problems and to see and learn about the latest types of equipment, materials and supplies that are continuously being developed to provide better service and reduce the cost of governmental operations. This outstanding exposition gives manufacturers and suppliers an opportunity to keep informed of the happenings in this billion dollar public works market and enables them to see the whole of which they are a part. The New York Coliseum, with its ultra-modern exhibit facilities, located in

Paul R. Screvane
Commissioner of New York City's Dept. of Sanitation will be General Chairman of the 1960 Public Works Congress & Equipment Show

the heart of the most sensitive news center in the world offers an ideal setting for the 1960 Show.

Commissioner Screvane has appointed twenty-eight public officials of the New York metropolitan area to serve on the Executive Committee. Those named to this committee are: Arthur T. Brokaw, Borough Engineer, Princeton, N. J.; Wolfe Chassen, Commissioner of Boro Works, Queens; Louis A. Cioffi, Commissioner of Boro Works, Manhattan; Stuart Constable, Exec. Officer, Dept. of Parks, New York City; Armand D'Angelo, Commissioner, Dept. of Water Supply, Gas & Electricity, New York City; A. F. Eschenfelder, Boro Engineer, Glen Ridge, N. J.; James Felt, Chairman, City Planning Commission, New York City; Arthur C. Ford, Pres., Board of Water Supply, New York City; Leonard Greenburg, Commissioner, Dept. of Air Pollution Control, New York City; Anthony Masciarelli, Commissioner, Dept. of Markets, New York City; Robert Moses, City Construction Co-ordinator, New York City; Raymond W. Murphy, City Engineer, Rye; Frank A. Nolan, Commissioner of Boro Works, Brooklyn; Vincent A. G. O'Connor, Commissioner, Dept. of Marine and Aviation, New York City; Charles L. Patterson, Chairman, New York City Transit Authority; Richard C. Patterson, Jr., Commissioner, Dept. of Commerce and Public Events, New York City; Michael A. Provenzano, Acting Chief Engineer, Board of Estimate, New York City; Harry A. Samberg, Commissioner of Boro Works, Bronx; George J. Schneider, Commissioner of Boro Works, Richmond, Staten Island; Seymour N. Siegel, Director of Radio Communications, Municipal Broadcasting System, New York City; Joseph V. Spagna, Commissioner, Dept. of Purchase, New York City; George E. Spargo, Gen. Mgr. and Secretary, Triborough Bridge and Tunnel Au-

OFFICERS: Jean L. Vincenz, San Diego, Calif., *President;* Frederick W. Crane, Buffalo, N. Y., *Vice President.* REGIONAL DIRECTORS: (term ending 1960) Charles W. Cooke, Hartford, Conn.; R. S. Hopson, Richmond, Va.; H. H. Hester, Fort Worth, Texas; (term ending 1961) Louis H. Moehr, Wyandotte, Mich.; John A. Morin, Oakland, Calif.; W. A. Bowes, Portland, Ore.; (term ending 1962) Paul R. Screvane, New York, N. Y.; Albert G. Wyler, New Orleans, La.; Edward J. Booth, Bismarck, N. D. *Immediate Past President,* Wm. D. Hurst, Winnipeg, Manitoba. Robert D. Bugher, *Exec. Director.*

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Key men in Commissioner Screvane's Department of Sanitation have been selected to head the various Local Committees. The Chairman and Vice-Chairman of the Management Committee are Henry Liebman, Director of Operations, and his assistant Richard Fenton. Mrs. Paul R. Screvane will serve as Chairman of the Ladies Committee. Other committees will function under the chairmanship of the following persons: Transportation, Deputy Commissioner Michael J. Fusco; Reception, Deputy Commissioner Jacob D. Menkes; Housing, Matthew J. Diserio, Assistant to the Commissioner; Prizes, Frank J. Lucia, Chief of Staff; Inspection Trips, Maurice M. Feldman, Chief Engineer, Bureau of Waste Disposal; Coliseum Arrangements, Alfred N. Gordon, Labor Relations Adviser; Exhibits, Edmund A. Donnelly, Director of Equipment Maintenance; Finance, Nicholas Lo Buglio, Secretary to the Department of Sanitation; Program, Casimir A. Rogus, Director of Engineering; Entertainment, William A. Kueper, Director of Training; Publicity, J. Donald Rodda, Public Relations Adviser; and Communications and Security, James V. Pettit, Captain-in-Charge, Inspectional Force.

Municipal Incinerator Personnel Management Practice in 12 Cities

A recent inquiry prompted the collection of data on municipal incinerator personnel management practice from cities having more than 500,000 population. The Association's query was answered by 12 cities operating a total of 34 incinerator plants. The reported data are summarized below in specific categories as follows: Organization of workers, seniority rights, absentee replacement, payment of overtime, lunch facilities and time allocation, employee benefits, maintenance and operational practice and salaries of various incinerator plant personnel.

Organization of workers—Two cities, the District of Columbia and New Orleans reported that plant employees were not members of a union. Four cities, Los Angeles, St. Louis, Houston, and Cincinnati reported Union membership was "optional." The remaining 6 cities indicated that incinerator workers were members of a Union.

Seniority rights—Ten cities indicated that seniority rights of the workers were recognized as follows: Buffalo—Choice of plants (selection prevails one year); Chicago —Eligibility for positions; Cincinnati—Determination of vacations and job assignments; Detroit—Lay offs and shift assignments; District of Columbia—(no specific comment); Los Angeles—Lay offs, vacations, shift assignments, civil service exam points; Milwaukee—Plant and shift choice of permanent duration, vacation choice on basis of seniority in present classification; Minneapolis—Selection of plants and shifts as vacancies occur; Philadelphia—Lay off and shift assignments; and St. Louis —Vacations only.

In all 12 cities actual work assignments were made by Management. Eight of the cities reported fixed shift assignments; Four: Baffalo, Chicago, Minneapolis and St. Louis reported use of a rotating shift assignment.

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Year 'round performance of unpaved roads depends largely on proper early spring maintenance. This consists of shaping roads to restore proper crown and adding binder soil or aggregate to consolidate the surfaces. Then add Columbia Calcium Chloride to:

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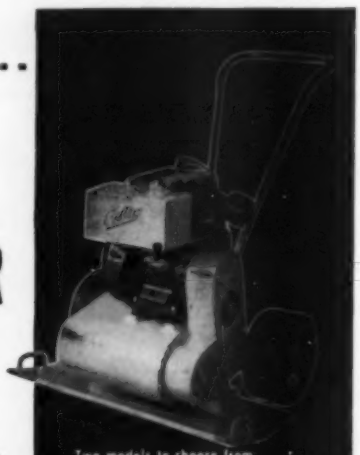

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Absentee replacement—The practice of allowing available personnel to work double shifts (if this is necessary) to replace absentees due to illness was reported by 9 of the 12 cities. The District of Columbia and Minneapolis reported complete reliance on recruitment from other sources or operating with less than a full crew. St. Louis reported use of less than a full crew with the exception of allowing a crane operator to work overtime until a swing operator can be called in. Chicago, Detroit, Philadelphia, and Los Angeles reported use of all three methods as the situation warranted. Buffalo and New Orleans reported reliance on the working of double shifts alone. Cincinnati and Houston used this method along with operating with less than a full crew if possible; Milwaukee used the double shift method where recruitment from other sources was not possible.

Payment of overtime—Four of the twelve cities, Cincinnati, Houston, District of Columbia and St. Louis reported use of straight compensation time off as the only means used to compensate for overtime. Overtime at the straight time rate only is paid incinerator workers in Buffalo and New Orleans, while in Los Angeles both overtime and compensatory time are given at the time-and-a-half rate. Detroit, Milwaukee, Minneapolis and Philadelphia reported overtime paid at the time-and-a-half rate. In Chicago overtime is paid in the form of compensatory time off, straight time on week days, time-and-a-half on Saturdays and double time on Sundays.

Lunch Facilities and Time Allocation—Six of the reporting cities (Buffalo, Chicago, Detroit, Cincinnati, Milwaukee, and Minneapolis) indicated that mid shift lunch periods were allowed; three reported half hour lunch periods and two,—a twenty minute period (one did not report). All of these cities except Cincinnati indicated that lunch room facilities existed at incinerator plants.

Employee (Fringe) Benefits—All twelve cities reported employees received paid vacations, paid sick leave, and paid holidays (Chicago specified that paid sick leave and paid holidays are given to monthly employees only). All the cities except St. Louis reported employees were covered by workmen's compensation; However, St. Louis indicated provision was made for on-the-job disability. Philadelphia also indicated on the job disability benefits (but in addition to workmen's compensation). Three cities, Buffalo, Chicago and Philadelphia, indicated

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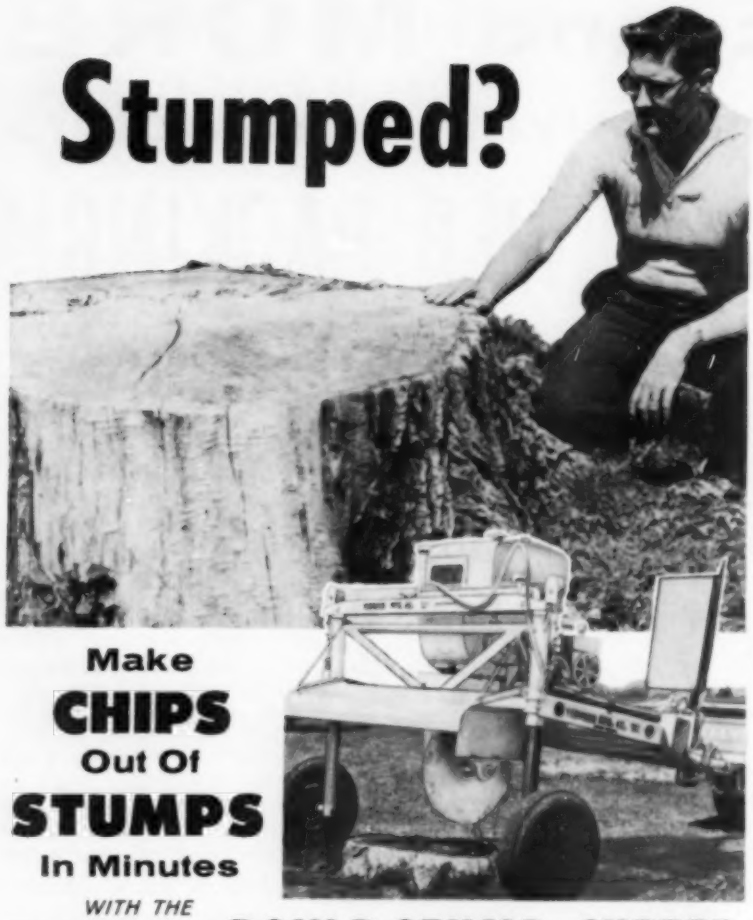

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employees received paid hospital and surgical care insurance, while Milwaukee reported partial payment of hospitalization along with a special death benefit. Detroit reported partial payment on a life insurance policy for employees.

Maintenance and Operational Practice—23 of the 34 plants operated by the 12 cities are operated on a three shift basis. Only one city, Houston, reported operation of its plants (four) on a standard two shift basis. Buffalo reported operation of one of its two plants on a two shift basis; Milwaukee reported two of its three plants operate on a two shift basis. New Orleans reported that the number of shifts varied in two of its three plants but one of the two ordinarily operated on a two shift basis and a second on a 1½ shift basis. Minneapolis reported operation of one of its three plants on a one shift basis (except from August 1 thru Sept. 15) and a second plant on a two shift basis.

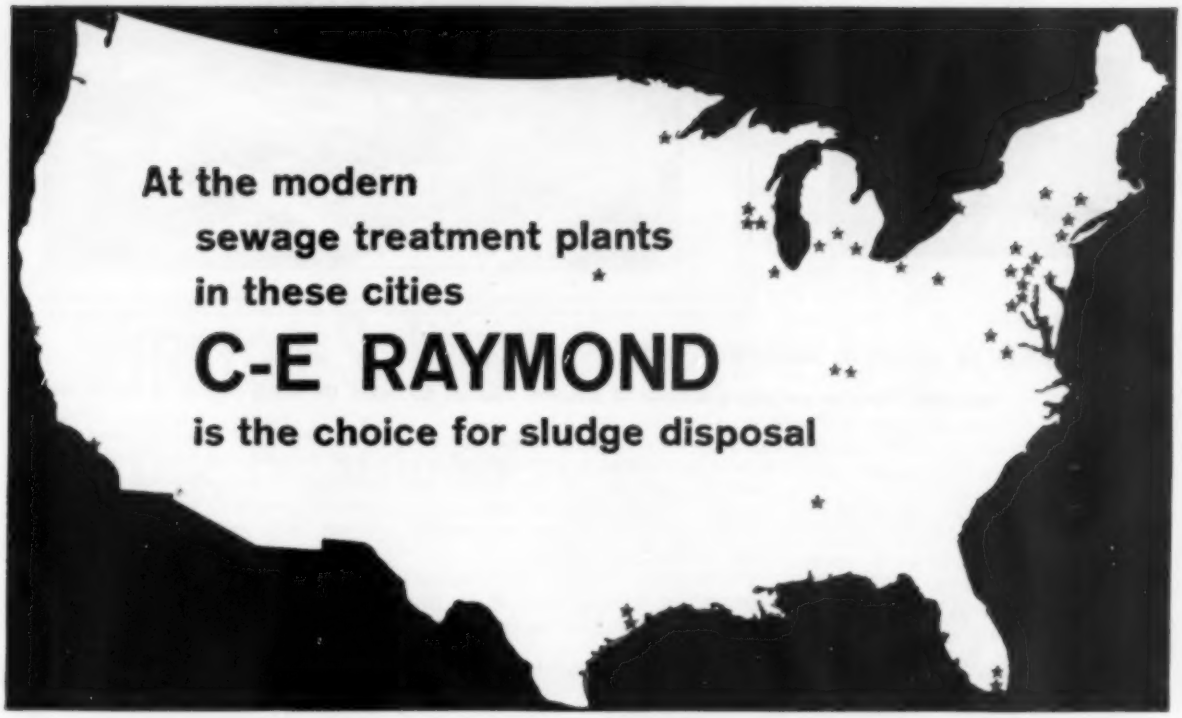
Generally, all cities indicated furnaces were overhauled as required during off peak months, working on one furnace at a time so that the complete plant would not be down at any one time. Specific comments were received as follows:

1. Chicago—Monday first shift used for cleaning up furnaces.
2. Cincinnati—4 weeks per furnace.
3. Detroit—Equivalent of one week.
4. Houston—1 to 5 weeks per year.
5. Milwaukee—6 weeks.

Annual Salaries — Reported average annual salaries, hours of overtime and overtime pay were tabulated for various plant personnel in the twelve cities. Titles listed are Chief Operating Engineer, Foreman, Attendant (Laborer), Fireman (Furnace man), Crane Operator and Truck Driver. A copy of the tabulation may be obtained from APWA headquarters.

Western Public Works Conference

The Central California Chapter will be host to the Bi-Annual Western Public Works Conference which comprises the 13 western states and is sponsored by the American Public Works Association. The Conference will be held in Fresno, Calif., May 16-18, 1960, with headquarters at the Hacienda Motel in Fresno. It is expected that this three-day Conference will attract between 600 and 1000 public works officials, suppliers, contractors and public utility engineers.



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★ **Communities in the United States which have selected C-E Raymond for sewage sludge disposal**

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Battle Creek, Mich.
Bethlehem, Pa.
Bloomsburg, Pa.
Buffalo, N. Y.
Camden, N. J.
Chicago, Ill.
Coral Gables, Fla.
Cuyahoga Falls, Ohio
Duluth, Minn.
Fond du Lac, Wisc.
Galveston, Texas
Harrisburg, Pa.
Houston, Texas
Jefferson Co., Ala.
Lansing, Mich.
Los Angeles, Calif.
Louisville, Ky.
Lynchburg, Va.
Miami, Fla.
Neenah-Menasha, Wisc.
New Albany, Ind.
New Rochelle, N. Y.
Omaha, Neb.
Petersburg, Va.
Pittsburgh, Pa.
San Francisco, Calif.
Schenectady, N. Y.
Sheboygan, Wisc.
Springfield, Mass.
Warren, Mich.
Washington, D. C.
Waterbury, Conn.
Wyomissing Valley, Pa.
York, Pa.

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Canada: Combustion Engineering-Superheater Ltd.

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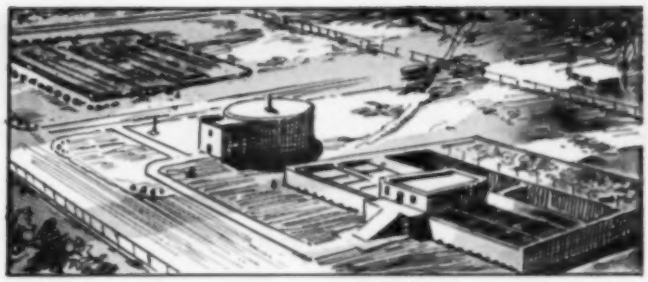
THE SEWERAGE AND REFUSE DIGEST



Prepared by **ALVIN R. JACOBSON, Ph.D**

Associate Professor and Head, Division of Sanitary Science, Columbia University School of Public Health

Sewerage Safety School

Brooklyn, N. Y., has had the good fortune of experiencing no deaths in their sewer maintenance work over the past 20 years. While luck may have accounted for some of their good fortune in the early years, they believe that their training facilities set up in 1951 have played an important role in maintaining this record over the past eight years. During this period many new industrial processes have actually increased the type and occurrences of dangerous fluids and gases in sewers. The Highway and Sewer Department personnel constructed the various training units from salvaged material, plus about $250 worth of new material consisting chiefly of several lengths of 36-inch corrugated steel pipe. The two-unit subsurface safety training installation comprises: (1) A full scale model sewer, completely above ground, consisting of 45 feet of 36-inch corrugated steel pipe leading into a brick manhole eight feet high, complete with sewer stubs, manhole head and cover. (2). A gas or smoke chamber standing about six feet from the manhole of the sewer assembly. The gas training chamber serves two primary functions: psychological conditioning to accustom trainees to the presence of non-viable atmospheric conditions while wearing gas masks; and to provide the actual setting in which trainees can acquire the skills associated with putting on, operating and taking off masks of various types in confined spaces. All supervisors and employees assigned to sewer maintenance work have been trained in detection of toxic and explosive gases and in the use of protective devices, especially gas masks, respirators and ventilators, and in first-aid procedures. Each employee receives the complete course in one day and all sewer maintenance personnel have been trained to date. To help promote such a program the author may be contacted for advice concerning their training operations.

"Brooklyn's School of Sewerage Safety." By Solomon Levi, P. E., Director of Safety. *The American City*, January, 1960.

Sewer Cleaning Reduces Complaints

With the initiation of a scheduled program of regular sewer cleaning the Public Works Dept. of Fredericksburg, Va., has almost completely eliminated perhaps the most unpleasant cause of citizens complaints. Previously the department was plagued with clogged sanitary sewers and storm drains. All sewer cleaning was handled on a complaint basis which resulted in disrupted work schedules and overtime work. The cleaning was done with a manually operated sewer rod, which was completely ineffective in many cases. It appeared that some storm drains and sanitary sewer mains were really inadequate and that they would require eventual replacement with larger mains. After a demonstration by the Ace Pipe Cleaning Company of the effectiveness of their sewer cleaning equipment, the City placed an order for the basic cleaning equipment which consisted of two units. Each unit includes a winch driven by a 9-hp gasoline engine. One unit is placed at the manhole immediately above the stoppage while the second unit is set at the first manhole downgrade from the stoppage. A cable with a bucket attachment is run between the two manholes and attached to the winches. The clamshell type bucket is pulled back and forth through the sewer main until all debris has been removed. Various other cleaning attachments such as "porcupine" brushes were also purchased to provide complete cleaning operations. The total cost of the equipment and attachments was $4,000.

● **MODEL of sewage treatment plant for Missoula, Mont., Clark & Groff, Salem, Ore., consulting engineers. Two primary clarifiers are provided, with space for an additional primary and two secondary clarifiers in the future. Trickling filters, shown at right and left, are also for future installation. Effluent from treatment plant will be discharged into Clark Fork River which is shown barely visible at top right.**

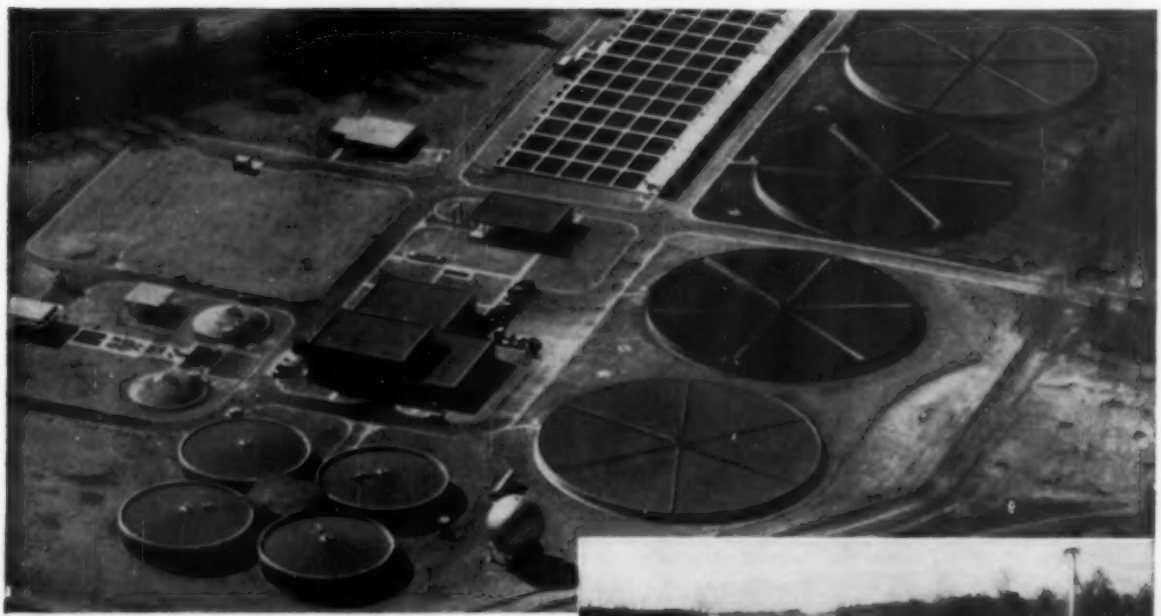
Winston-Salem is Big Business

When a city jumps from 13,600 to 93,000 in population in less than four decades—you have "bigness" in growth. When that same city becomes a leading industrial center and has an industrial waste almost equivalent to its expanded population—you have "bigness" all over again. Winston-Salem is that city!

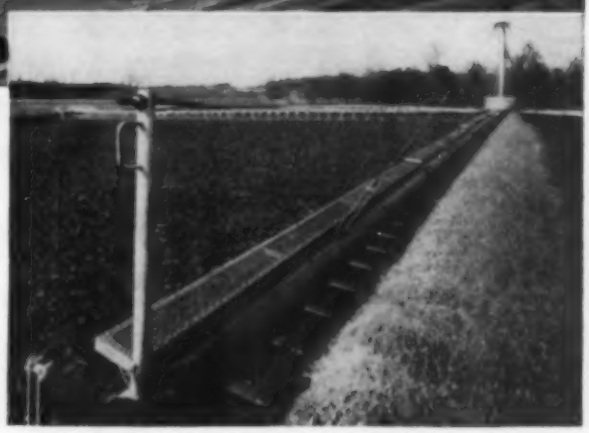
The four giant P.F.T. Rotary Distributors, 200′ in diameter, are characteristic of this tremendous growth. Equipped with specially designed P.F.T. Spreader Jets, for uniform distribution, these soundly engineered and ruggedly constructed distributors handle a flow of 25.0 mgd!

Other P.F.T. equipment in this modern sewage treatment plant, capable of handling a population equivalent of 200,000 and designed by Piatt and Davis of Durham, N.C., includes: Four 90′ Floating Covers, three complete Pearth Gas Recirculation Systems (the fourth digester is arranged for future Pearth which can be installed without interrupting digester operation), three P.F.T. #750 Heaters and Heat Exchangers that are gas and oil fired, Gas Safety Equipment, Supernatant Equipment and Floating Cover Gauge Boards with High and Low Level Alarms.

Crack engineering and construction teams, along with high quality P.F.T. sewage treatment equipment, gives progressive Winston-Salem truly a plant to be proud of.



(*Above*) This is Winston-Salem's Sewage Treatment Plant. Engineering skill and modern treatment equipment makes this plant one of the finest in the country



(*Right*) 3 tons of bronze forgings are incorporated in the four P.F.T. Rotary Distributors at Winston-Salem. The P.F.T. Spreader Jets are two-piece forged bronze units with removable deflectors.

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"New Cleaning Machines Cure Sewer Complaints." By Clifford Rusch, Administrative Assistant, Office of the City Manager, Fredericksburg, Va. PUBLIC WORKS, February, 1960.

County Sewage Treatment Plant

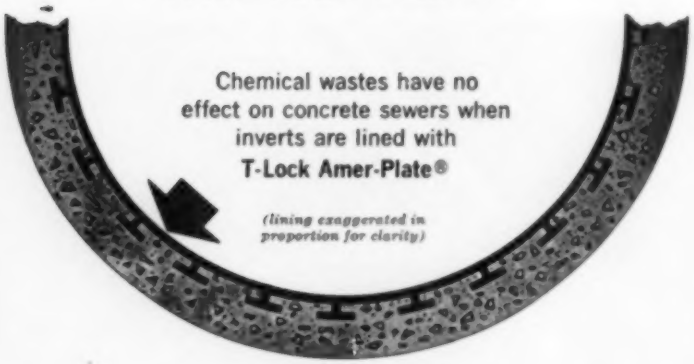
The North Davis County Sewer District comprises portions of Davis and Weber counties in northern Utah, an area of some 50,000 acres. Installations served include eight municipalities; Hill Air Force Base, employing in excess of 10,000 workers; and the Clearfield Naval Supply Depot, employing approximately 1,500 workers. The District has experienced a rapid population growth, from 5,677 in 1940 to a present estimated figure in excess of 26,000. The sewer district was organized in 1954 and after a thorough study of the requirements it was determined that a two-stage high rate filter plant should be constructed, based upon an ultimate population of 225,000. The initial plant was designed for a flow of 9.5 mgd, and an equivalent population of 74,500, including 32,500 industrial equivalent population. The raw sewage enters the plant through a mechanically cleaned screen, equipped with grinder, thence through a grit separator and into the primary clarifier. The effluent from the primary clarifier is conveyed to the primary filter and the primary filter effluent flows to the intermediate clarifier and this clarifier effluent is lifted to the secondary filter. The sludge from the intermediate and final clarifiers is returned to the primary clarifier so that all sludge is pumped from the primary clarifiers to the two digesters which are operated in series. The under-drainage from the twelve drying beds is returned to the primary pumping station for recirculation through the plant. The construction cost of the plant was $1,300,000 and the plant maintenance and operating expense for 1959 was budgeted at $49,000.

"County Treatment Plant for Industrial and Municipal Wastes." By Win Templeton, Templeton and Linke, Consulting Engineers, Salt Lake City, Utah. PUBLIC WORKS, February, 1960.

Syndets and Oxygen Transfer

A number of types of synthetic detergents, and particularly the surface active agents which comprise their active constituent, have been studied in laboratory apparatus with reference to their influence on oxygen transfer in bubble aeration. A gross coefficient of oxygen transfer for the experimental system has been used to evaluate the relative effects of the surfactants, the types of water used, and various additive salts and builders. From the results of this research and the applicable theoretical considerations, the following are some of the conclusions drawn: (1). Synthetic detergents profoundly affect oxygen transfer in bubble aeration, usually in an adverse fashion. (2). These effects were found to be in general agreement with their surface activity, as measured by the criterion of surface tension, increased surface activity, and decreased surface tension resulting in increased interference with oxygen transfer. (3). For three homologous series of alkyl benzene sulfonates, the gross coefficient of oxygen transfer exhibited a generally decreasing trend as the number of carbon atoms in the alkyl chain increased. (4). The presence of salts in water influences the effect of most surfactants on oxygen transfer significantly. (5). Sodium tripolyphosphate builder caused additional reduction in oxygen transfer in the presence of the polypropylene

How to Protect Concrete Sewers from Chemical Wastes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benzene sulfonates, but only small or insignificant changes for the straight-chain types.

"Effects of Detergents On Oxygen Transfer In Bubble Aeration." By William O. Lynch and Clair N. Sawyer, Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Mass. *Journal Water Pollution Control Federation*, January, 1960.

Nucleonic Sludge Analyzer

Comparative tests carried out at the Back River Sewage Treatment Plant of the City of Baltimore have demonstrated two facts of importance in the handling of sludges which are being delivered to digestion tanks: 1) The ability of a nucleonic analyzer to determine the solids content of such sludge, on stream, without the need for repeated sampling and laboratory analyses; and 2) a practical, workable and acceptable comparison between nucleonic analyses and the determination of sludge solids by recognized standard methods. The density analyzer consisted of three parts: A density measuring head, a preamplifier, and a density measuring instrument, together with the necessary interconnecting wiring. Immediately adjacent to one side of the pipe was a radioisotope source, consisting of cesium 137, with a half-life of 30 to 33 years. Directly opposite, on the other side of the pipe, a radiation detector was located. The principle of the operation of the density measuring head was as follows: A portion of the radiation was intercepted by the solids in the sludge and the remainder passed on to the detector, the amount of radiation detected being in inverse proportion to the sludge content. A detector permitted an electric current to flow, in proportion to the radiation received, this current being increased by a preamplifier and permitted to flow to a density measuring instrument calibrated to indicate the percentage of solids in the sludge. The results of the study indicate that density analyzers which are now available from manufacturers can serve a useful function at sewage works, especially where sludge is pumped into sludge digesters.

"Checking Density of On-Stream Sludge With Nucleonic Analyzer." By C. E. Keefer, Sewerage Engineer, Bureau of Sewers, Baltimore, Md. *Wastes Engineering*, January.

Curved Sewers

This discussion summarizes an evaluation of the use in the United States of curved or curvilinear alignments for residential sanitary sewers, as distinguished from the conventional practice wherein only straight runs are allowed between manholes. The study undertaken on behalf of the Federal Housing Administration was initiated by a mail canvass to some 126 sanitary engineers throughout the country followed by field visits to 66 communities where curved sewers were known to have been used, of which 43 were located in California. Information was collected from each community on the following aspects: 1) History of curved sewer utilization; 2) physical data on curved sewer installations; 3) acceptance procedures (on completion of construction); 4) location of sewer and of connections (after sewer is in use); 5) construction costs (including contractor's costs, field engineering; and inspection); 6) maintenance; 7) hydraulic design; and 8) over-all evaluation of curved sewers. From this study it was concluded that a large majority of the communities which have used curved sewers are still willing to install

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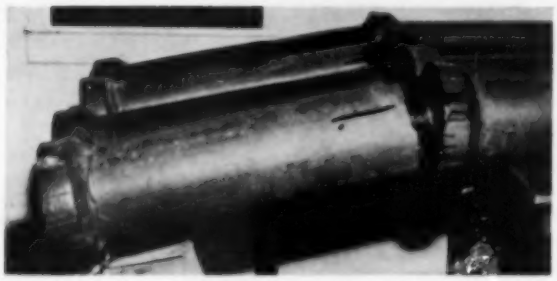
Hydrostatic tested installed lines show consistent negligible leakage

ROOT-SEAL Hot Pour Plastic Joints



Four Root-Seal hot poured joints after uniform 10 degree deflection under high stress and still no damage to joint seal.

ROOT-SEAL JOINTS on vitrified clay pipe TESTED BY leading independent laboratory show 100% water tightness with interior hydrostatic pressure held at 40 psi.

Tests by leading municipality show after 7° deflection ROOT-SEAL is 100% water tight at minimum 10 psi.

ROOT-SEAL has been tested by Smith-Emery Company, Los Angeles, Calif., and found to conform to the "Performance Standards" dated November 14, 1951, and Specifications for Hot-Pour Sewer Joint. Compound dated June 12, 1953, established by National Clay Pipe Manufacturers, Inc. ROOT-SEAL has been tested and found to conform to Federal Specification SS-S-169 Type III Plastic Class 1 Hot Pour.

FOR ENGINEERS: Specifying ROOT-SEAL provides installation crews with proven materials that meets all national accepted "Standard of Quality," is easy to inspect, meets the toughest infiltration test when installed properly, with the following physical properties. *Adhesion*: Safe against ground water infiltration, roots and damage by water soaking. *Flexibility*. Safe against pipeline settlement and movement.

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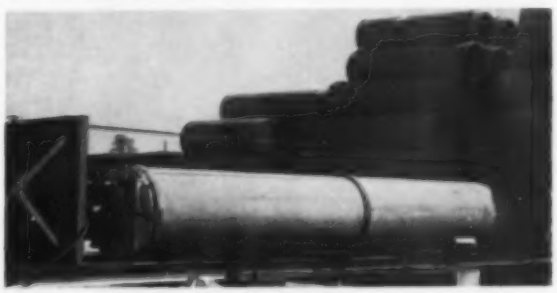
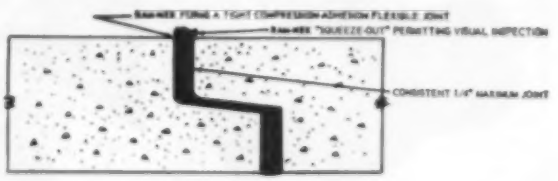


A 15" diameter irrigation pipe with one ¾" gasket of RAM-NEK holds average 15 psi—internal hydrostatic for 24 hours—no leakage.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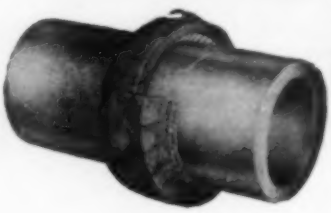

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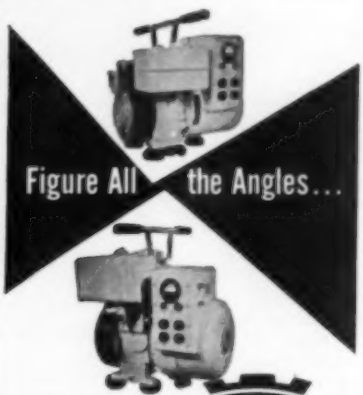

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them under some conditions, and that at least 50 percent will use curves whenever they are economically justified. The employment of curved sewers is well established in the U. S. and will likely become more popular, particularly in view of the increasing trend toward the use of curved streets in new subdivisions (in flat as well as hilly terrains). Only a few cities have indicated dissatisfaction and in these instances the dissatisfaction stemmed not from the curves per se but from faulty construction or inadequate records.

"Feasibility of Curvilinear Alignments for Residential Sanitary Sewers." By Harvey F. Ludwig. *Journal Water Pollution Control Federation*, January, 1960.

Other Articles

"Sewage and Waste Disposal." Investigation into **septic tanks** in **series**. By G. Lloyd Ackers, O.B.E., M.I.C.E., F.R.S.H., P.P.I.P.H.E. Concluded **here** is a discussion on septic tanks in **series**. Contractors Record and Municipal Engineering, December 30, 1959.

"Air Application in the **Activated Sludge** Process." A discussion of air diffusion theories, particularly concernning the effects of turbulence and the application of narrow band diffusion techniques. By Douglas E. Dreier. PUBLIC WORKS, February, 1960.

"Assessing Sewage Pollution of **Bathing Beaches.**" Bacteriological standards impracticable reported the research committee of the Public Health Laboratory Service in the Medical Research Council's Memorandum on Sewage Contamination of Bathing Beaches in England and Wales. The Surveyor, 16 January 1960.

"Progress in Wastewater Treatment and **Pollution Control** in 1959" tells of the growing need for agreement among waste treatment officials if progress is to continue. By Dr. Mark D. Hollis, President, Water Pollution Control Federation (formerly F.S.I.W.A.). Water & Sewage Works, January, 1960.

"Water Quality Criteria." Third Progress Report of the **Aquatic Life** Advisory Committee of the Ohio River Valley Water Sanitation Commission which discusses radioactivity and aquatic life, detergents, cyanides, phenolic compounds, iron and manganese. Lloyd L. Smith, Jr., Chairman, Dept. of Entomology and Economic Zoology, University of Minnesota. Journal Water Pollution Control Federation, January, 1960.

"Quelques Applications Pratiques de la Tuyere **Electromagnetique** pour la Mesure des Faibles Vitesses." The authors describe the working principle of the electromagnetic nozzle which consists of measuring the flow-velocity of a liquid by means of the electrical field induced in it by a magnetic field. La Houille Blanche, Decembre, 1959.

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Aquatic Weed Control by Chemicals

In a paper before the Northeastern Weed Control Conference, Madelene E. Pierce of Vassar College, Poughkeepsie, N. Y., reported on a study of Long Pond, Dutchess Co., N. Y. Kuron was applied to the pond in 1957, 1958 and 1959 to determine the effect on the biota in the treated areas. Treatments applied in 1957 with a follow-up surface spray in 1958 showed, during the summer of 1959, a vast improvement in the reduction of certain weeds. *Pontedaria* was completely non-existent. *Nymphaea* was present only in scattered patches and submerged *Utricularia* was definitely decreased.

Another area treated in 1958 with 2 ppm and with a follow-up treatment in 1959 at 1.2 ppm gave complete control of *Nymphaea odorata* and *Nuphar*. The submerged weeds of the shallow area were at least held in check. *Utricularia* responded more successfully than *Chara*. In the deeper area, several species of *Potamogeton* were not decreased. For a few days after treating, plankton were reduced but after two weeks regained normal numbers and vigor. There was no effect on fish, frogs and turtles in the area.

R. K. Huckim of Chipman Chemical Co., reported on weed control at Carnegie Lake, N. J. Aquatic weeds had been a real problem for the recreational use of the area since 1953. This lake has a fairly high rate of flow which increases the problem of vegetation control. Copper sulfate at high rates and mechanical mowing failed to control the aquatic weeds.

In April and May, 1959, 100 acres were treated with 20 lbs. per acre of 2, 4-D acid equivalent applied as a clay granule. Observations a month after treatment indicated that 95 percent control of water milfoil was obtained and no appreciable regrowth appeared for the remainder of the season.

In areas adjacent to those treated, heavy infestation of *Potamogeton* and *Cabomba* occurred in August and were treated with granular 2, 4-D at 40 to 60 lbs. per acre acid equivalent. The results of these late treatments were not clear at the end of the season. Sodium aresenite at 20 ppm in summer treatment gave about 75 percent control of *Potamogeton*, *Cabomba* and *Ceratophyllum*.

Changing weed population probably will require variation in treatments to maintain control.

How Subsurface Water was Handled in Deep Sewer Lines

AS PREDICTED in the August issue of PUBLIC WORKS, the $23,180,000 trunk sewer construction program in Orange County, California, is on schedule. Lee M. Nelson, general manager of the County Sanitation Districts stated in that issue that the 103 miles of new trunk sewer would be practically completed by December, 1959.

The problem of engineering this complex of trunk sewers, treatment plants and ocean outfall was foreseen by the County Sanitation Districts whose board of directors approved expenditures for preparation of plans and specifications six months before the bond issues were passed by district voters. Working from previously developed studies of needs by John A. Carollo, Consulting Engineer of Phoenix, Arizona, four engineering firms, the Carollo organization, Don Southworth of Costa Mesa, J. R. Lester Boyle of Santa Ana, and Sidney L. Lowry of Santa Ana, were commissioned to complete the plans. The former was selected for its experience with the program and the latter three for their knowledge of local conditions. Each was assigned a distinct portion of the program. The Boyle and Lowry firms also teamed in a joint venture for overlapping parts of the program.

By using the talents and staffs of the consulting engineers the County Sanitation Districts were able to provide a completely engineered system without employing a large temporary staff and at considerable savings to the Districts.

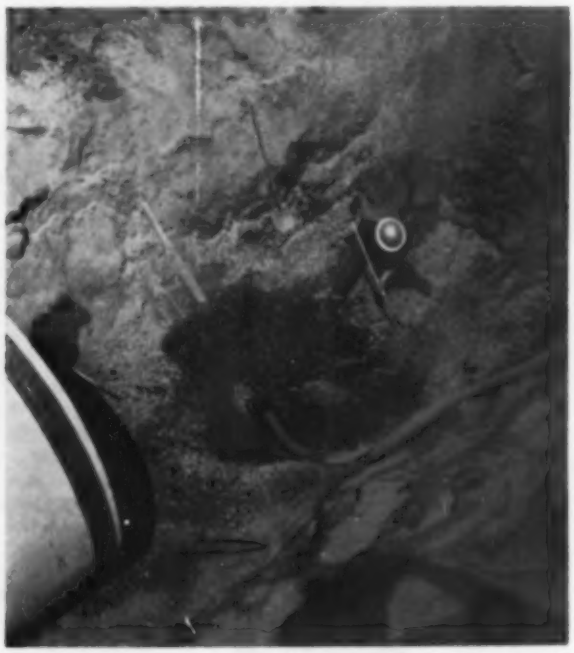
As plans were completed, the engineers and the District staff programmed construction. Representatives of the area Sewer Contractors Association were called in and a list of qualified contractors and their bonding capacity was developed. This list enabled the Districts to program the work in contract amounts and complexities within the scope of the available contractors.

Time, as Mr. Nelson pointed out in his August article, was tremendously important due to rapid local population growth. Health officials had ruled that, unless the necessary system expansion was completed by the end of 1959, they would halt all new building. Therefore it was vitally important to get as much work under way as possible as soon as possible, making the coordination of the Districts, engineers and contractors of interest to all.

Contract awards began in October, 1958, and have continued since in a steady stream. They range from a $58,946 contract, covering the installation of 4,000 feet of 12 to 18-inch clay pipe as an interceptor, to installation of more than 34,000 feet of 24 to 78-inch diameter reinforced concrete pipe at a contract bid of $2,667,727. By September, 1959, the Districts had awarded a total of 24 contracts on bids totaling approximately $20 million, and the program was well on schedule.

To many familiar with the complications of southern California construction, particularly under-

● **CLOSE** coordination of the work on this project is illustrated by pipe layers, foreground, and trencher at rear.



● **GROUND** water, about 7 ft. down, was handled by electric pumps set in wells in trench and parallel to it, 30 ft. off.

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ground projects of such magnitude, the fact that the program is on schedule as regards both time and money is surprising. The problems were many, not the least being a conflict of interest with other government agencies and public utilities.

The County Sanitation Districts met and solved these problems. A legal skirmish with the California State Highway Department concerning costs of sewer relocations in case of subsequent highway construction was won by the Districts. Conflicts of interest between the Districts and other utilities—electric, natural gas and water—were resolved by negotiation. Right-of-way acquisition was placed in the hands of top men. Condemnation procedures were used if needed. A possible long, drawn-out battle with the railroads over the type, method and liability responsibility of undercrossings was settled amicably—albeit in favor of the Districts, which took a firm stand and won. There were very few problems with individual property owners and communities over street closures and similar temporary inconveniences. Everyone recognized the value of the work.

Contracts were all standardized. General provisions were drawn up by the Districts and included in each contract. Technical provisions for each section of the program were standardized by the engineering firm responsible for its development. The engineers also were responsible for inspection on the projects and assigned enough men to that work to insure rapid progress.

Problems in Construction

The past history of Orange County underground construction showed an uncomfortably high natural ground water table aggravated by heavy runoff from the thousands of acres of irrigated farm land and by encroachment from the Pacific Ocean. The contractors knew this. They knew that before they hit the halfway point of their excavations, often 30-ft. deep, they would be deep in water. They had to get rid of the water before they started digging or costs would skyrocket.

Conferences with area specialists uncovered one method popular among miners—pre-dewatering with electric-powered, submersible, centrifugal pumps. The pump engineers and contractors designed systems using over 40 of these pumps. On these particular applications two models of Flygt pumps are used, 1½-inch B38s and 3-inch B80s. The pumps are powered both from existing surface lines and from portable electric sets. The portable power units are 30-W Caterpillar diesel electric sets. The contractor, J. S. Barrett Co. of Santa Ana, ran three and four pumps continuously off these power units.

Well shafts were sunk approximately 30 feet off and parallel to the center line of the sewers and 300 feet apart along those stretches of the lines where dewatering was required. Because excavations are carried to as much as 35 feet below the surface, well shafts usually are sunk to a depth of 50 feet. This insures dewatering well below construction operations. Over most of these lines ground water is encountered below a depth of around 7 feet. Work along the coastal flats has the additional problem of tidewater raising and lowering ground water levels. Contractors in this area are placing pipe 21 feet below sea level.

The dewatering well shafts are bored with truck mounted cesspool augers. The shafts are lined with 30-inch welded steel casing. Centered inside the liners are 16-inch perforated steel pipe the depth of the well. The space between these pipes is filled with crushed stone or gravel and the solid steel liner is removed. This allows the perched water at all levels to flow freely into the well.

Light in weight and easily handled by two men, the pumps are lowered to the bottom of the well shafts on rope. The connecting electric cable is strung to the power source, plugged in and the pump goes to work. Water is discharged through flexible hose to disposal facilities. Fully submersible, the centrifugal Flygt pump operates continuously with no attention and can handle a high degree of solids easily. Predewatering was started two or three weeks before excavation began.

This Flygt pre-dewatering method was developed first on a Weardco Construction Co. contract for installation of a pumping station. The contractors developed a Flygt-powered pre-dewatering plan after consultation with pump engineers. The southern California dealer for the pumps, Gridley Equipment Co. of Los Angeles and western U. S. Distributor, Stanco Manufacturers & Sales of Santa Monica, helped engineer the installation from their experience on other applications. Other contractors watched closely as the first job progressed and when the system appeared perfect they quickly programmed the method for their operations.

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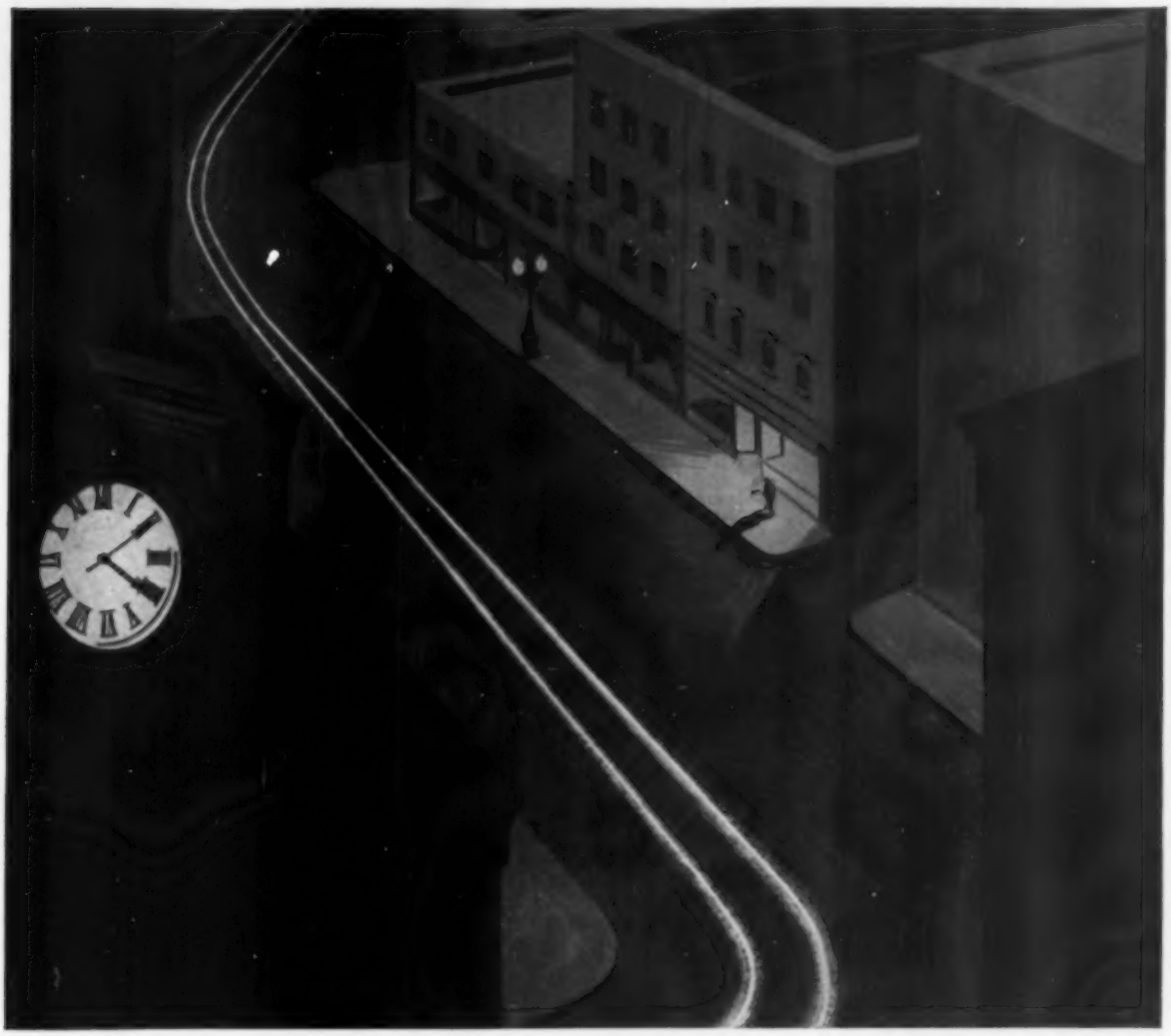

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THE HIGHWAY AND AIRPORT DIGEST

Prepared by **FRANK FORCE,** ***Digest Editor***

Placing Embankments on Poor Foundations

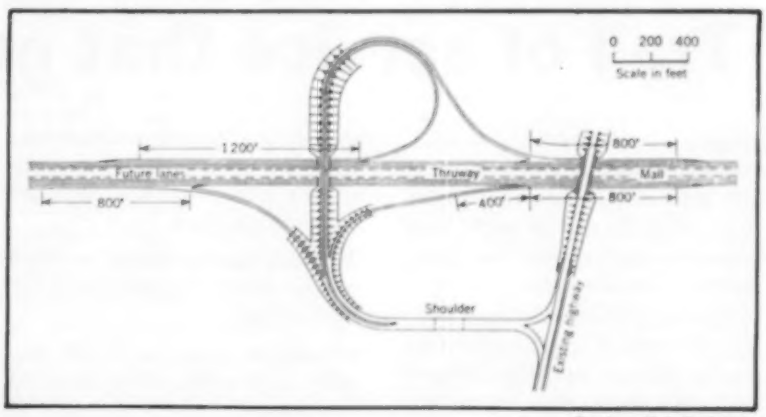
There are seven basic methods of treating a swamp problem in placing an embankment. They are compression, blasting, displacement by overloading, removal and replacement, lightweight embankment, lateral dewatering and sand drains. Compression is the simplest and cheapest method, but it is limited in application. It is usually efficacious when the thickness of the poor material is small and the height of the embankment is several times the thickness. Blasting is employed to hasten the compaction of the underlying material without resorting to heavy overloading or to aid in the displacement of the soft underlying strata. Displacement by overloading is distinct from that produced where the underlying material was compressed in place. When the embankment crosses an extensive swamp and no property question is likely a portion of the underlying poor material can be pushed out sideways. The displacement will continue until a state of equilibrium is reached. Removal and replacement is generally an economical procedure up to a depth of 15 ft., but special cases may warrant this limit to be considerably exceeded. The lightweight embankment method is used comparatively infrequently. There are, however, cases where the underlying material is too low in bearing capacity to support the proposed weight of fill but it could support a load of less amount. Lateral dewatering is used when the instability of the foundation on which the embankment is to be placed is due to the presence of water. Dewatering is usually done in sandy soils and in some silty soils. It can be said that sand drains constitute the great contribution of the soils engineer to the solution of the poor foundation problem. By the controlled removal of the internal water, combined with coordinated loading, inferior soils can gain in strength during the construction of the embankment.

"Placing Embankments on Poor Foundations." By Walter L. Braybrooke, Goodkind & O'Dea, Consulting Engineers, Bloomfield, N. J. *Better Roads*, December, 1959.

Geometric Design of Modern Highways

The first important step to study in the geometric design of highways is the matter of separating opposing roadways. The median strip may vary on trunk highways where the separator varies from a barrier type a few inches in height and width, to others with medians so wide that opposing roadways cannot be seen one from the other. In open country, where right-of-way is no problem, the varied-width mall or median is the ideal design. Because of the high cost of real estate in urban areas, expressways in cities must be designed with narrower separators. A portion of the New York State Thruway in Yonkers has a curbed median 12 ft. in width. The problem of headlight glare is present and should experience so dictate, it is possible to construct, within the 12 ft., a positive barrier which will prevent both headlight glare and head-on collisions. The second factor of importance is the matter of the relationship of the geometry in plan to the geometry in profile Utmost care must be taken in correlating plan and profile at the interchanges. The ideal location for an interchange is on a tangent near the sag of a vertical curve connecting two long descending grades. The next most desirable location is on a tangent or a curve of very long radius where the gradient is uniform. On the Thruway the trumpet-type interchanges, which are particularly satisfactory for toll roads, require a minimum distance of about 3,000 ft. along the axis of the expressway from the beginning of the exit ramp to the end of the entrance ramp. It is well to consider the fact that in addition to regular interchanges, the modern expressway will eventually have to provide rest areas, service areas and perhaps other facilities for the use of the public.

"Geometric Design of Modern Highways." By C. H. Lang, Chief Engineer, New York State Thruway Authority, Elsmere, N. Y. *Civil Engineering*, January, 1960.



Courtesy Civil Engineering

● **TRUMPET interchange, as used on N. Y. Thruway, is economical and functional.**

New Tractor Shovel brings new economies to small town

Michigan introduces Model 55A, early purchaser reports it does many jobs previously skipped (or handled by $10/hr. rental units)

Like many small communities, the Village of Pewaukee, Wisconsin, for years handled loading and clean-up chores with a farm-type tractor and various pieces of rental equipment. As may be expected, costs were high. But so too, reasoned the Village Board, would be the initial expense of buying a bigger machine . . . especially to a town of only 2000 people.

Then last spring, Aring Equipment Co, Michigan Distributor in Milwaukee, showed the new Michigan 1 yard Model 55A. Price, with trade-in, under $10,000. Back-hoe, snow plow, sweeper, a lot of other attachments could be added later.

Everyone was impressed. It was easy to figure how this unit's four-wheel-drive, speed and versatility could cut expenses. Also, how it might handle the many jobs previously not done at all or, at best, done inefficiently.

"Since then," says Gary Boyce, Pewaukee Supt of Public Works, "we've used our Michigan *for everything*." For instance . . .

Saves $50 weekly rental at the sanitary landfill. The Village makes a monthly pick-up; between times, villagers dump their own trash and rubbish. Once a week a rented crawler would clean up; between times the dump was messy. Now, the Michigan, with 26 mph mobility, runs out every day or two. Clean-up is done quickly, the old $10 per hour crawler rental expense is eliminated.

Cleans lakefront. Located on a popular resort lake, Pewaukee has the problem of keeping its beach clean. Lake residents and motor boats cut weeds. Prevailing winds blow them to shore . . . sometimes piling them a foot thick. Previously, each cleanup took 15 man hours . . . "hand hours" since the farm tractor couldn't work in sand. Now, the Michigan wades in hub-deep, shoves weeds onto shore, loads them in truck. In *one hour* the job's done.

Stockpile-loads sand, salt, blacktop, stone. The power steer, powershift Model 55A with 1 yd bucket heaps a 5 yd truck in five passes, 2 to 2½ minutes. Pewaukee's old farm-type loader took 5 to 7 minutes for the same job . . . *if* the material wasn't frozen.

Takes place of truck. When trucks are busy, the Michigan may carry its own load a block or a mile or more. Street patching is a good example. Here, the 26 mph Model 55A carries a yard of blacktop down the street —stops at potholes—operator or helper hand-shovels and packs in materials as needed.

Tree trimming. Due to inadequate equipment, this once was a chore rarely attempted. Now, the Michigan, used as a fast-moving lift-truck, raises a man up to 8 feet off the ground for trimming with chain saw or 18 foot pruner. Thus street lights have been made more efficient . . . traffic hazards removed.

These are but a few of the jobs where the 66½ hp Model 55A is saving time, trouble, and money for the Village of Pewaukee. Let us show you, first-hand, how it can do the same for you!

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Principles of Soil Engineering

The subject of soils engineering will be discussed under three major headings in PUBLIC WORKS Magazine. "Part I—Physical Properties" appeared in the February issue "Part II —Design Considerations," and "Part III—Construction Applications" will appear in later issues. One of the most practical complications that occurs to an engineer is the fact that soils appear to vary so much from spot to spot and from season to season. Each engineering material has its own special definitions and conventional approaches. To some extent, the differences are neither necessary nor warranted, but have resulted from empirical development along separate, non-integrated lines. In other cases, certain properties are more critical with one material than with another so that they are ignored in one case and accentuated in another. In soils, three properties are of importance: 1) volume-weight relations, 2) grain size, and 3) soil moisture. Classification of soils of some type is accomplished by all practicing soils engineers, and is a prerequisite to a systematic evaluation of the problem. In the article, classification is discussed under the headings of 1) laboratory tests, 2) field identification and 3) classification systems. The three systems of classification described are: Highway Research Board; Unified Classification System; and Pedalogic Classification. The three engineering properties of soils that are of interest relate to shear, settlement and permeability. As a summary of Part I, it can be said that the soil properties that are essential to an understanding of the basic behavior of soils under stress have been described.

"Principles of Soil Engineering, Part I." By Robert F. Baker, Professor of Civil Engineering, The Ohio State University, Columbus, Ohio. PUBLIC WORKS, February, 1960.

Building a Light Bituminous Surfaced County Road

The Federal Highway Act of 1944 formulated a three-way partnership of state, county and federal governments for the sole purpose of improving secondary roads. In the state of Washington, the mileage allowable on the county system is limited to those roads which can be constructed within a reasonable length of time and the roads chosen must make an integrated system and must be integrated either directly or through another feeder route with a primary federal-aid route. In Douglas County, the grading and drainage are done with county funds. The federal-aid funds are used for bituminous surfacing of routes that have been previously constructed. The county gets from 10 to 12 miles of bituminous surfacing per federal-aid project. The largest single item in any of the surfacing projects is the quantity of crushed rock. Consequently, these jobs are usually bid by crushing contractors. They, in turn, sublet the actual bituminous surfacing to an oiling contractor. Seventy-five percent of the total cost of building a light bituminous project is in furnishing and placing the rock. In most instances, crushing contractors work two 9-hour shifts. Because of the summer heat and water-production problems, a great deal of the processing and laying must be done at night in order to save water. Crushed rock is placed on the roadway by means of bottom-dump wagon trains and a good operator can lay the rock to the desired thickness so that very little preliminary grading work is required. Water is added and the crushed rock is immediately processed on the roadway. On subgrades

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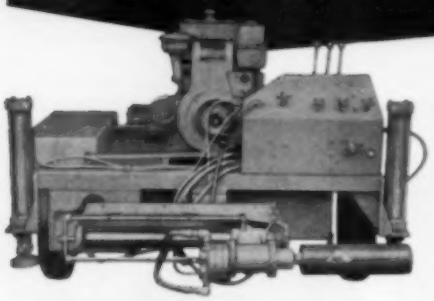

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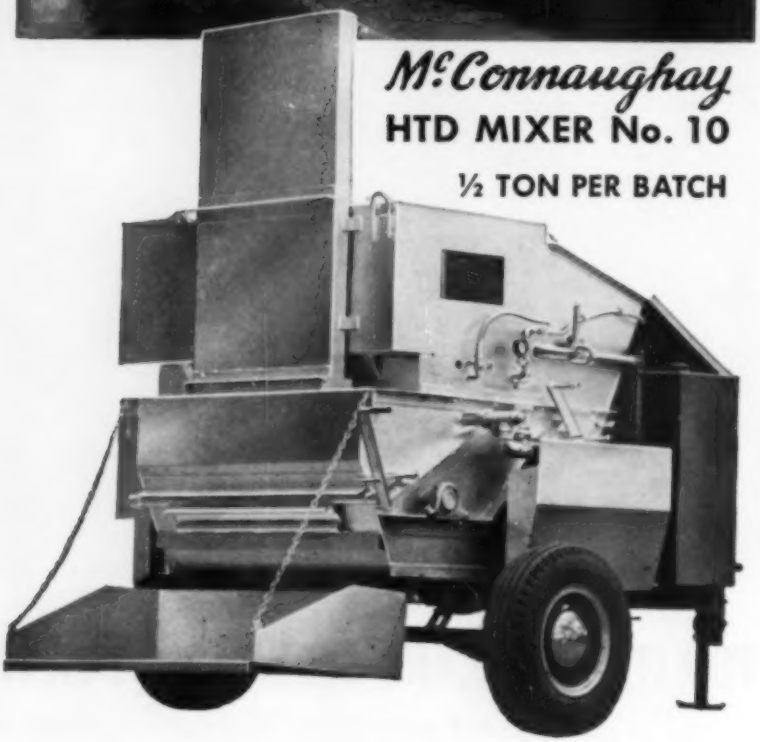

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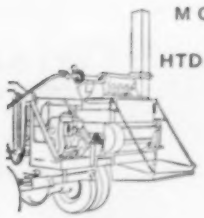

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that have been previously ballasted under the grading contract, 5 in. of compacted 1¼-in. and smaller aggregate is used in the base and 4-in. of ¾-in. and smaller aggregate is used in the top course. The light bituminous surface-treatment mats range from 1¼ in. to 1¾ in. in thickness. Two shots of MC-3 asphalt are applied, the first at 0.65 gal. psy and the second shot at 0.35 psy. The oiling contractors have developed the use of self-propelled spreader boxes. A tight shooting surface is required and a light shot of water is applied just preceding the oil shot and this is rolled immediately with a steel-wheel roller. This is followed by the oil shot and cover-stone application and rolling by a steel-wheel roller. A pneumatic-tired roller is used to finish the surface.

"How a County Builds a Light Bituminous-Surfaced Road." By Pat Thomson, Douglas County Engineer, Waterville, Wash. *Better Roads*, December, 1959.

State Develops Specifications for Consulting Services

A comprehensive contract "Specifications for Consulting Engineer Services" has been developed by the Ohio Highway Department to achieve uniformly acceptable results in work performed by consulting firms. These specifications are divided into five major sections. Section 1 covers definitions and serves the prime purpose of establishing a uniform interpretation of critical words and phrases. Section 2, General Clauses and Covenants, sets forth the State's requirement on those items that are common to all phases of the consultant's work. Section 3, Preliminary Engineering Report (Arterial or Route Report), serves the basic purpose of providing an analysis and determination of the most feasible locations for highway facilities, between limits as identified in the engineering agreement, to the accuracy necessary for the holding of a public hearing. Section 4, Design Report, requires the State's written approval of fundamental design elements such as alinement and profile; proposed typical roadway sections; preliminary interchange and intersection designs; and other roadway design features. Section 5, Construction Contract Plans, lends emphasis to the fact that the sole purpose of the construction plan is to develop and provide the State with adequate design details and related documents for receiving and evaluating comparable competitive construction bids, and to provide the

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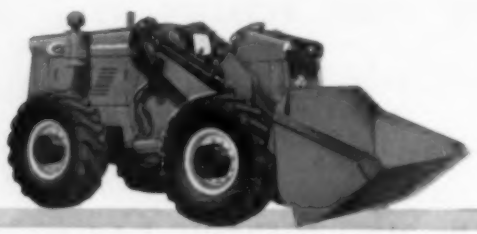

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contractor with sufficient details to build the improvement.

"Ohio Develops Specifications for Consulting Services." By E. S. Preston, Director, Ohio Department of Highways, Columbus, Ohio. *Civil Engineering*, January, 1960.

Developing a Tree Planting Program

To become an eligible starter in the race for beauty, a municipality needs a master street-tree plan. Parma, Ohio, was one of the first to have one in the Cleveland area, in 1956, but there are 36 Greater Cleveland suburbs which now have the plan—and more are being added yearly. Tree maintenance programs have been denting municipal budgets for many years. In the United States last year, cities and homeowners spent some $40,000,000 to rectify tree mistakes and public utilities spent even more for trimming or removing trees that were interfering with overhead lines or luminaires. Edward H. Scanlon and Associates, Consulting Arboriculturists, devised a master street-plan to help alleviate the Cleveland Electric Illuminating Company's tree problems and benefit municipalities and homeowners as well. They started in Parma and surveyed every street and recorded 17 items: Street name; block number; direction; width of paving; sidewalk tree lawn; lot; building setback; building height; truck or bus route; character of street; overhead lines; street lighting; ground factors; remarks about existing trees; and conditions and recommended treatment. From these facts they selected a tree for each street—a variety which will not conflict with any of the site factors when it reaches maturity and which will enhance the property. The trees selected for Parma will mature at a height between 16 and 35 ft. They have either outstanding form, colored bark, colored leaves, or flowers—and very often a combination of these qualities. Forms may be globular, oval, pyramidal, columnar, pendulous or conventional. Flowers may be red, pink, white or yellow. Bark may be orange, lemon, mahogany, brown, white, red or green-and-white striped. Leaves may be yellow, green, red, gray, orange, plum or red and yellow.

"More Small Flowering Trees Wanted." By Leslie Morgan, Street Tree Commissioner, Parma, Ohio. *The American City*, January, 1960.

A Novel Paving Plant

A low-level aggregate batch plant, with a belt feed to transit-mix trucks, was used economically in laying 10.5 miles of wire-mesh-reinforced concrete on Route I-94 in southern Wisconsin—a total length of over 42 miles of 12 ft.-wide pavement, in the two dual-lane separated roadways. Materials handling was arranged to provide completely automatic batching by one man. Sand and two sizes of stone were hauled in from a commercial source at about the rate of use and were dumped into low 40-cu. yd. bins, which fed conveyors for delivery to the batch plant. Cement was hauled in by truck to a Rex 485-bbl. bin that had an automatic weigh batcher on the side, over a truck runway. Water came from two 300-ft. deep wells in the area and was stored in three tanks. The most desirable sequence for loading aggregates, cement and water into the transit-mix trucks was worked out by numerous trials and resetting of time delays. The panel board for batch control has numerous time delays and circuits. Two concrete-mix designs can be simultaneously set on the board. Moisture variation in the sand is kept under control by using a Mark X water meter. Each

HI-WAY Model R Seal Coater

Handles all Aggregate from Sand to Crushed Rock. Priced to Make Even Small Jobs Profitable!

There's a HI-WAY Model R to handle your seal coating job—from narrow 8′ drives and close-in work to 13′ roadways, using all aggregates from sand to crushed rock. A swivel type, self-coupling hitch permits fast hook-ups or disconnections with any truck. Requires no installation of cab controls. Smooth, uniform spreads are assured by a large 5½″ dia. feed roller with right and left cut spirals. Block-off plates, one 1-ft. and one 2-ft., are easily inserted for precise width of spread. Top notch workmanship and material assures minimum maintenance.

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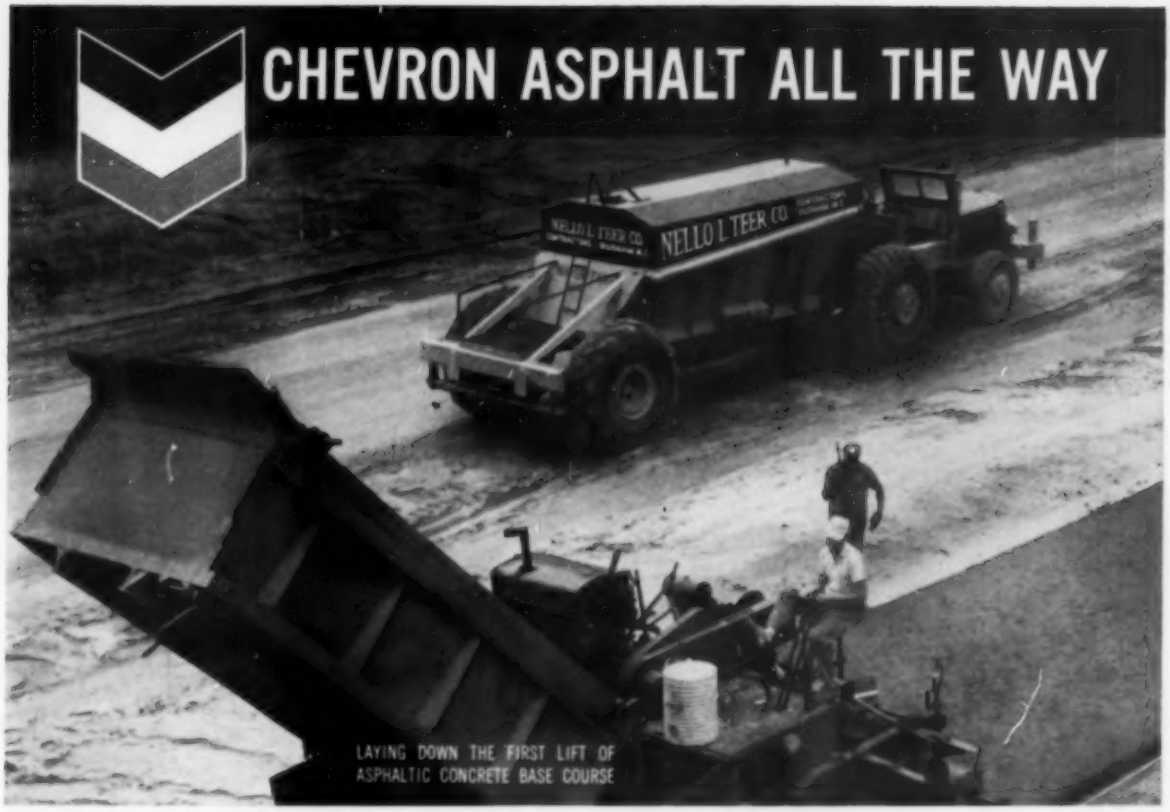
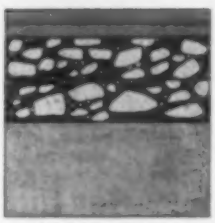


Nello L. Teer Company Job In North Carolina Includes Record Asphalt Paving Award



CROSS SECTION VIEW OF PAVEMENT CONSTRUCTION

On Interstate Route 95, North Carolina, the Nello L. Teer Company, of Durham, North Carolina, is the prime contractor on a highway construction project that includes the largest asphalt tonnage contract ever awarded by the North Carolina Highway Dept.

This project fittingly crowns 50 years of activity in the construction field by the Teer Company.

The job called for new construction of divided pavement each side 24' wide, south from the Harnett County line 14.55 m. to a point 5 m. north of Fayetteville.

The paving contract covered the placement and compaction of 7" to 12" of mechanically stabilized base; placement and compaction of Asphaltic Concrete "Black Base" course in two 3" lifts; and placement and compaction of Type I-2 Asphaltic Concrete wearing surface in two 1" lifts. Asphalt surface treated shoulders were provided full length over a mechanically stabilized base.

Overall, the "Black Base" and I-2 Wearing Surface required 210,000 tons of Asphaltic Concrete.

All work is being done under Project 8.13438. Sponsor: North Carolina State Highway and Public Works Commission. Resident Engineer: H. B. Smith; Division Engineer: J. W. Spruill, 6th Division, Fayetteville, N. C.

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cycle of the plant consists of 6 cu. yd. and the capacity of the plant is one truck every 1½ min. or 240 cu. yd. per hour.

"Success With a Novel Paving Plant." By Douglas E. Small, Resident Engineer, Wisconsin State Highway Commission. *Civil Engineering*, January, 1960.

Operation of An Electronic Traffic Signal System

Bloomfield Ave. is an arterial route extending from the edge of Newark, N. J., in a westerly direction through the towns of Bloomfield, Glen Ridge, Montclair, Verona and Caldwell. The traffic situation on Bloomfield Ave. in 1957 indicated the need for a more flexible traffic signal system than the single-dial, single-offset equipment that was being used. The traffic volume was 25,000 vehicles per day. After studying the various types of modern control equipment, the Electromatic PR System was selected. The essential features of this system include the following: 1) Traffic sampling detectors are used to detect vehicular movements in the two principal directions and provide the master control at all times with information on the comparative volumes of traffic; 2) the master control computes the volume rate of traffic flow in each direction from the impulses sent in by the detectors and automatically puts into effect the cycle length that has been chosen for each level of traffic volume; 3) local intersection controllers operate within the cycle length and offset plan selected by the master; and 4) multiconductor cable was selected to interconnect the master control with all intersection controllers. A system of 21 signalized intersections was planned covering 3.2 miles. Radar vehicle detectors were installed to sample the traffic flow. A telephone circuit was incorporated into the system which helps speed servicemen in making adjustments. A daily schooling program continues throughout the year in an effort to keep the personnel abreast of the new developments in the field.

"Operation of An Electronic Traffic Signal System." By Dan J. Murray, Supt. of Maintenance, Essex County Highway Dept., Livingston, N. J. PUBLIC WORKS, February, 1960.

Soil-Cement Street Program

Zion, Ill., a town of 11,000 people, passed two bond issues for street and other improvements in 1958. One, for $1,000,000 for storm sewers and soil cement streets, was a general obligation issue to be retired from motor fuel and vehicle tax funds. The other, $250,000 for sanitary relief sewers, was financed by water and sewer revenues. The two contracts, totaling $981,505, were awarded for 10.5 miles of concrete storm sewers and 11 miles of streets ranging in width from 32 to 41 ft., back to back of curb. The street improvement was a 6.5 in. soil-cement base course with triple bituminous surface treatment. The storm sewer to be laid was chiefly 18-in. reinforced concrete pipe but with some sections 8-in. to 60-in. After grading, curb and gutter were formed to 19 in. width from back of the roll-type curb to toe of gutter. After the curbs had set two days, the forms and their 30-in. pins were picked up on a truck equipped with A-frame hoist and carried to the next location. The soil-cement process was done in the following sequence: 1) Scarify and pre-wet; 2) spread bulk cement; 3) dry-mix with "Pulvimixers"; 4) add water and continue mixing; 5) compact with pneumatic-tired roller; 6) shape with grader and continue compact-

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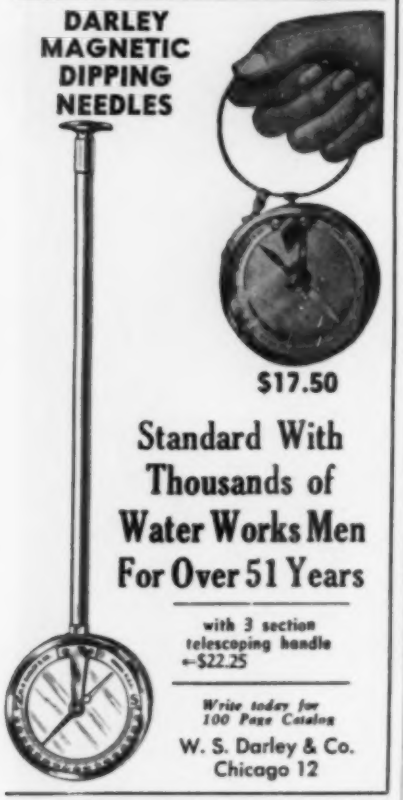

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ing; and 7) roll with a tandem roller. The surface treatment consisted of a cure coat of RC-2 asphalt on the soil-cement base at the rate of 0.2 gal. per sq. yd. After curing, the A-2 surface course, consisting of two layers of $\frac{3}{8}$-in. cover coat and one layer of $\frac{3}{4}$-in. pea gravel, was rolled into an SC6 on bituminous material. Cost of the soil cement base course was $1.25 psy.; the triple surface coat, $0.25 psy.

"Soil - Cement Street Program Spruces Up Whole Community." By James R. Cummings, Associate Editor. *Street Engineering, January, 1960.*

Other Articles

"Reflectorized Pavement Striping at Minimum Cost." Marion County, Oregon, striped a total of 524.6 miles of roads at an average cost of $23.41 per mile in 1959. By John A. Anderson, Marion County Engineer, Salem, Ore. PUBLIC WORKS, February, 1960.

"How a County Highway Engineer Handles **Public Relations.**" By Pat Thomson, Douglas County Engineer, Waterville, Wash. PUBLIC WORKS, February, 1960.

"Waste Screening Surface Shoulders on Bituminous Roads." Medina County, Ohio, bermed 35 miles of road in 1958 and 32 miles in 1959. By W. W. Anderson, Medina County Engineer, Medina, Ohio. PUBLIC WORKS, February, 1960.

"Sensible **CBD Traffic Plan** for a Small Community." By Graham W. Watt, City Manager, Alton, Ill. Street Engineering, January, 1960.

"Rock Salt Storage on the New Jersey Turnpike." By Harold W. Goldberger, Assistant Engineer of Maintenance, New Jersey Turnpike Authority. Constructioneer, January 11, 1960.

"For Highway Crews, **Houses on Wheels.**" Texas Highways, January, 1960.

"Cement Test." New rapid method determines **cement distribution** in bases. By Daniel R. Howe, Soils Engineering Associate, Materials and Research Department. California Highways and Public Works, November-December, 1959.

"Exceptional Job Engineering Pays Off on **Bridge Construction.**" By Ira E. Williams, Resident Engineer, Tulsa District, Corps of Engineers, Whitesboro, Tex. Civil Engineering, January, 1960.

"New Equipment—On Our Highways." Earthmoving equipment, compactors and vibrators, bituminous pavers, concrete pavers and aggregate production equipment are a few of the machines mentioned. By H. A. Radzikowski, Chief, Division of Development, Office of Operations, Bureau of Public Roads, Washington, D. C. Civil Engineering, January, 1960.

"Highway **Bridge Practice.**" New developments spurred by highway program are new welding techniques, high-strength bolts, composite construction and electronic computers. By Glenn S. Paxson, Assistant State Highway Engineer, Oregon State Highway Dept., Salem, Ore. Civil Engineering, January, 1960.

"Road - Surface Maintenance in Maine." By Page Johnson, Division Engineer, Maine State Highway Commission, Ellsworth, Maine, Civil Engineering, January, 1960.

"Training Employees to Represent Highway Department." Four training conferences for right-of-way personnel of Texas Highway Department had as their objective to equip men with best tools and techniques available for working with the public in obtaining highway right-of-way. They were highly successful. Better Roads, December, 1959.

"Racine **Tests Snow Program** and Equipment." The Wisconsin city, crippled for days in 1947 by a 15-in. snow, dug itself out of a heavy 1959 fall in 24 hours. By Henry A. Nelson, Commissioner of Public Works, Racine, Wis. The American City, January, 1960.

"Cleaner Streets in El Paso, Texas." Equipment matched to the job, good programming and close operating control add up to cleaner streets. By E. F. Muckelroy, Supt., Dept. of Sanitation, El Paso, Tex. The American City, January, 1960.

"Proper Compaction of **Asphalt Pavements.**" High pressure tires, heavy loads, call for high-density pavements. By Fred Kimble, Materials Engineer, Ohio Highway Dept., Columbus, Ohio. Asphalt Institute Quarterly, January, 1960.

"The Manufacture and Use of **Supersulphated Cement.**" Supersulphated cement is a hydraulic binder, based on granulated blast furnace slag and has special properties, notably a very high resistance to aggressive solutions and a low heat of hydration. Contractors Record and Municipal Engineering. December 16, 1959.

"Winning Designs in **Elevated Motorway Competition.**" The Surveyor, December 12, 1959.

"Standards for **Storm Water Facilities.**" The metropolitan St. Louis Sewer District has established new standards for storm water ditches in order to reduce erosion, to lower maintenance costs and to provide engineers and builders with definite data for storm sewer and ditch design. PUBLIC WORKS, February, 1960.

• • •

Northwest Highway Engineering Conference

The Northwest Conference on Road Building and the Northwest Traffic Engineering Conference will hold a combined conference at Oregon State College, Corvallis, March 23 to 25. Coordinators are Prof. Martin P. Cooney, Apperson Hall, Oregon State College, Corvallis, and J. Al Head, Asst. Traffic Engineer, State Highway Dept., Salem, Oregon.

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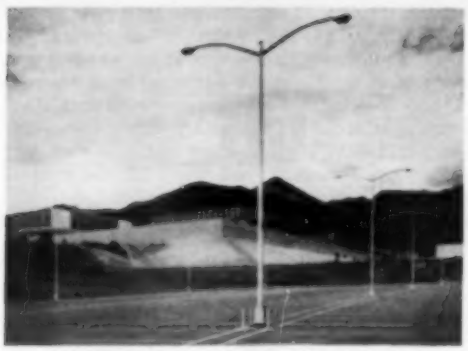
ROADWAY leading from the North Gate to the Cadet-Academic Area.



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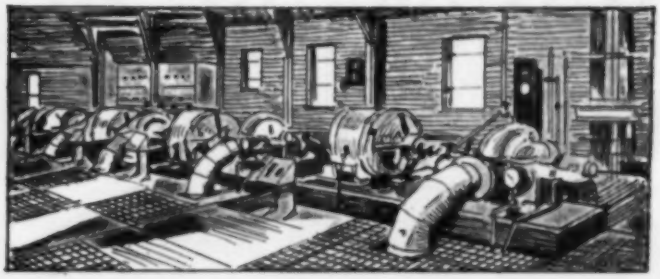


Prepared by **ALVIN R. JACOBSON, Ph. D.**

Associate Professor and Head, Division of Sanitary Science, Columbia University School of Public Health

Fluidization of Floc Particles

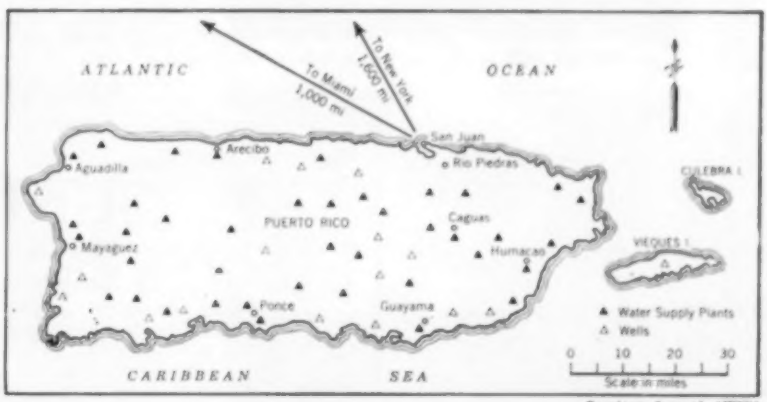
As a result of the Hydrodynamic Institute of The Czechoslovak Academy of Sciences having been asked to study a problem arising in industry, the author was able to define certain general concepts concerning the fluidization of particles in suspension in water. The work described in this paper includes experiments concerned with fluidized beds consisting either of identical particles (spherical) or of completely irregular particles (flocs). For fluidization in water, an approximately linear relationship was found between the mean real velocity and porosity; apparent weight being approximately equal to drag. The process of fluidation is considered to be flow around the individual spheres making up the bed. Using dimensional analysis the author has obtained a comparatively simple equation involving dimensionless quantities and connecting the drag coefficients and Reynolds numbers. As far as hydraulics is concerned, the method of water treatment known as sludge blanket treatment is a fluidization phenomenon. The floccular suspension is attracted to the surface of the flocs forming the sludge blanket in the same way as it is held inside a rapid filter by sand adsorption. It was seen that, for a given quantity of untreated water and for a given quantity of reagent, sludge concentration diminished as flow velocities through the blanket increased. Flow in the sludge blanket was seen to be turbulent flow above the blanket. The energy resulting from fluctuations in the blanket causes the flocs to break up and mixes them with a resultant decrease in turbulence in the upper parts of the sludge blanket.

The results of experiments conducted with the test installation were used in designing a new type of sludge blanket clarifier.

"Fluidization des Particles Granuleuses et des Flocans dans L'eau." Par Igor Tesarik, Ingenieur A L'-Institut d'Hydrodynamique de L' Acadamie des Sciences de Tchecoslovaquie. *La Houille Blanche*, Decembre, 1959.

Puerto Rico Authority

Puerto Rico with a population of 2,314,000 inhabitants in an area of 3,435 sq. mi., or a population of 673 per sq. mi., has a number of obvious social, economic, and public health problems but it is also evident that spectacular progress is being made in their solution. Responsibility for solving two of these problems, the supply of drinking water and the discharge of sewage, rests with the Puerto Rico Aqueduct and Sewer Authority. Each of the 75 cities and towns with a total urban population of 1,000,000 and about 580,000 of the 1,300,000 Puerto Ricans in rural areas are served with drinking water which meets the USPHS requirements of potable water. Moreover, 63 cities and towns now have sanitary sewer service and six additional systems are being constructed. A governing board executes the powers of the Authority. It is composed of five members ex-officio, namely, the governor of Puerto Rico, and the secretaries of public works, health, treasury and labor. The board appoints an executive director (who is the senior officer of the Authority), a controller and a treasurer. One of the first steps taken by the Authority was the introduction of uniform rates throughout the island, effective July 1, 1956. Three important stipulations in the rate structure were: (1) the establishment of a minimum charge which should be paid even though no water is consumed; (2) consideration of the government as any other customer with no privilege of free water service; and (3) a charge for sanitary water service, for those connected to the sewers, at the rate of one third of the cost of water service. In 1949 the Authority floated its first issue of revenue bonds in the amount of $22,700,000 to carry out its first 5-year program. In 1957,



Courtesy Journal AWWA

● **LOCATION of water plants and wells in Puerto Rico. Water meeting USPHS standards is supplied to 75 cities and towns and to half the rural population.**

Why this "magnetic" meter has no troublesome stuffing box

With Rockwell Sealed Register meters you will never again need to service worn or leaky stuffing boxes —for there are none: A simple, powerful magnetic coupling transmits every motion of the measuring chamber direct to the register without a mechanical coupling or seal.

Stuffing box maintenance is only one way you'll save with these revolutionary meters. You'll gain substantially through a construction in which only two moving parts operate in water—all others run snug, dry and lubricated for life in a hermetically sealed register housing.

Too, the sealed register construction assures that condensation or dirt can never collect underneath the glass to make meter reading difficult. And you can even run this meter under water without harm.

The cost for all this? No more than you pay for ordinary meters—less in fact than for meters fitted with special type registers. Get facts today, write Rockwell Manufacturing Company, Pittsburgh 8, Pa.

POWERFUL MAGNETIC DRIVE
Illustrating how the driver magnet (held in hand) revolves around a watertight compartment at base of register to push the follower magnet, which in turn drives the register shaft.

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the Authority sold another $12,000,000 revenue bond issue. Water production at present is 90 mgd, 89 per cent of which is fully treated and filtered in 36 plants serving 53 towns and cities. Another group of towns is served from deep wells, after chlorination. Moreover, all this water is fluoridated to a concentration of 0.8 ppm fluorine. Recently the 24-mgd primary sewage treatment plant was placed into operation, this being a part of the $32,000,000 project accomplished by the Authority to serve San Juan Metropolitan Area. As Harry E. Jordan states in his discussion of this article, the author has modestly understressed the rapidity with which water and sewage works have become available to the people since 1945. What he has written merits careful reading and rereading.

"Puerto Rico Aqueduct and Sewer Authority." By Rafael V. Urrutia, Executive Director, Puerto Rico Aqueduct and Sewer Authority. *Journal A.W.W.A.*, January, 1960.

Price of Accidents

One area in which it is still possible to effect major economies is safety. The amount of money needlessly wasted on accidents in the water industry each year is astounding. Accidents are not only more frequent today; they are also more expensive. Damage to valuable equipment, suits for damages resulting from accidents involving the public, and the loss in production created when a single employee is disabled—not to mention the expense of workmen's compensation and other benefits common in today's complex society—all these add up to an astronomical figure of more than 12 billion dollars in 1958 according to the National Safety Council. This money, which is needlessly wasted on accidents each year, is minor compared to the toll in human suffering. Every 30 minutes, five people in the U. S. lose their lives through accidents, and 548 more are injured—and this goes on hour after hour, day after day. Accident problems differ from the normal operational problems of a water utility, in that accidents are primarily caused by human failure. And any improvement in safety performance will be in direct proportion to the effort exerted by management. The Los Angeles Department of Water and Power has a very effective seven-point safety program, which, having functioned for 3 years, has brought about a definite and measurable increase in safety performance. The program is, briefly: (1) Weekly on-the-job safety meetings are held in which talks are presented by the foreman to their crews on specfic work operations. (2) Six meetings are held each year for discussion of topics for the weekly meetings and to advise foremen on the most effective means of presentation. (3) An organized system of job instruction has been developed for new employees. (4) The foreman is required to assemble his crew after an accident occurs and discuss with them the cause of the accident, and how it could have been prevented. (5) Safety committees, composed of all levels of supervision, have been established. (6) A signboard is mounted on the side of each truck showing man-days worked without a lost-time injury. (7) In recognition of good safety practice, a plaque is awarded to each crew working a year without lost-time injury. Any water utility can enjoy substantial reductions in cost of operation as the result of a well planned, integrated safety program when supported fully by top management.

"The True Price of Accidents." By George C. Sopp. Joint System Head & Asst. Mgr., Dept. of Water

This Changing World

For hundreds of years, the fastest Man could travel was by riding a running horse at about 35 miles per hour. In 1830 the steam engine was invented, and then in 1910 the airplane which today travels at over 600 miles per hour. Man's weapons have changed from a slingshot to a spear to a bow-and-arrow to gun-powder to nuclear bombs. The only thing which never changes is change itself . . . change goes on almost continuously in myriad ways.

American cities have been steadily increasing in population and likewise spreading out into suburbs and "suburbs of suburbs". So more water is needed and distribution mains need to be longer with more valves and fire hydrants and more footage of main per customer. Engineering experts agree that to give adequate service, U. S. water and sewage facilities today need to be doubled!

Why do so many people face this spectacle of almost continuous and eternal change with a stoical indifference which history shows often has been an obstacle in the path of progress? Why not ask John Q. Public for advice? He might be flattered. He might realize that the water problem is his problem too, and become more interested in its solution.

This series is an attempt to put into words some appreciation of the water works men of the United States.

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At Public Service Electric and Gas Co., Sewaren, N. J.

Bitumastic coatings resist 11 years of abrasive salt-water attack

Loading docks of Public Service Electric and Gas Company's Sewaren Generating Station are subjected to unusual corrosive attack by the Arthur Kill, a bay-like tidal river between New York and Staten Island. Added to the river's salt water content are floating debris and effluent from industries and oil refineries located along its shores.

To cope with these severe corrosive elements, 11 years ago Public Service's engineers specified that the steel piling for the station's loading docks and sea wall be coated with Bitumastic® No. 50. For added weathering protection, piling exposed above the low-tide level also was given an additional coating of Bituplastic® No. 28.

FOLLOWING 11 YEARS OF EXPOSURE, PUBLIC SERVICE'S ENGINEERS REPORT NO MAJOR RECONDITIONING OF THE PILING HAS BEEN NECESSARY. This utility's experience is not unique: four other installations fronting the Arthur Kill have had similar success with Bitumastic coatings on submerged piling.

The Bitumastic line includes a coating for every industrial corrosion problem. For on-the-job assistance to keep your corrosion costs down, call your nearby Bitumastic distributor or return the coupon. Koppers Company, Inc., Tar Products Division, Pittsburgh 19, Pa. District Offices: Boston, Chicago, Los Angeles, Pittsburgh, New York and Woodward (Birmingham), Ala. In Canada: Koppers Products Ltd., Toronto, Ont.

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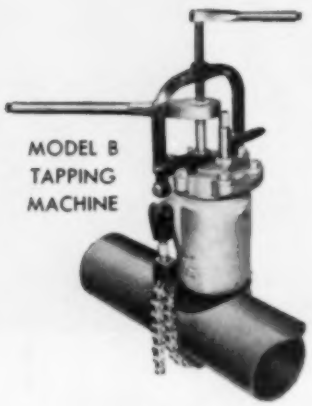

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ERIE, PA.

& Power, Los Angeles, Calif. *Journal A.W.W.A.*, January, 1960.

Municipal Hydrologist

The Wichita, Kansas, water department retains a hydrologist on its staff to keep the director informed of the day-to-day and long-range problems, solutions and studies in the field of water supply. He must be a graduate civil engineer or geologist and have extensive knowledge of principles, practices and equipment used in water supply and production. At the present time the City's supply consists of 55 wells located some 25 miles northwest of the City in what is called the "Equus Beds." The City also maintains and uses 30 wells located in the filter plant area within the City. From the population growth curve and a corresponding water use curve, the City realizes that at some time in the future additional raw water supply will be needed. Thus it becomes necessary to study all ground water resources in the area. Considerable research has been done in the Equus Beds well field to determine the hydraulic coefficients of transmissibility of the aquifer and the related determination of individual well efficiencies. Much information has been collected through the years from the drill cuttings of each test hole or new well. Development of methods to increase recharge by artificial means is another duty assigned to the hydrologist. One method is through wells using surface run-off water. Another form of artificial recharge under investigation contemplates induced recharge along both the Little Arkansas and the Arkansas Rivers. Variation in flow, chemical quality, sediment load and methods of development of the Little Arkansas River have been investigated to a considerable extent. All of the work and research findings by the hydrologist will be reported for future reference and much of it will be eventually published.

"Municipal Hydrologist Provides First-Hand Data on Water Sources." By G. J. Stramel, Hydrologist, City Water Dept., Wichita, Kansas. PUBLIC WORKS, February, 1960.

Plastic Pipe

Recently a special survey was completed by a committee of the Plastic Pipe Research Council to find the answers to several questions concerning the use of plastic pipe in municipal water supplies. Questionnaires were sent to 1,337 superintendents and managers of water works in cities with populations of 5,000 or over throughout the country. Responses were received from 326 engineers or about 25 per cent of the group contacted. Of these, approximately one-third replied that they had used plastic pipe. Using this as a yardstick, it might be assumed that approximately one out of every 13 water works engineers has used plastic pipe for water works service, either experimentally or for standard uses. According to the survey, the two major uses of plastic pipe are: 1) water distribution; and 2) chemical lines in filtration and treatment plants. The one-inch pipe was the most prevalent size in use with ¾-inch a close second. Flexible and rigid plastic pipe found about equal employment in the water works field: 51 companies used polyvinyl chloride or acrylonitrile-butadiene-styrene (ASB) pipe; 40 used polyethylene. Sixty-five per cent of the water works engineers using plastic pipe have found that the pipe has given satisfactory service. Taste and odor complaints are no longer a problem when plastic pipe is installed that has been given the approval of the National Science Foundation after extensive tests. Methods of repair are available from the manufacturers, as are temperature-pressure data. Research is being carried out by a number of manufacturers to develop pipe suitable for the transportation of hot water. It is only a matter of time before hot water pipe and the use of plastic pipe in sewers become a reality.

"Plastic Pipe for Water Systems. How Is It Used? How Does It Work?" By Martin E. Flentje, Chief Sanitary Engineer, American Water Works Service Co. *Water Works Engineering*, January, 1960.

National Water Grid Scheme

The author has amplified and clarified some of the original proposals submitted in a previous article (Surveyor, 24 October, 1959) on this important subject of obtaining and distributing water. The plan consisted of proposals for improving existing mutual assistance between British water authorities and for coordinating future schemes, together with a degree of augmentation, on an overall national scale. The author has also answered several of the comments and criticisms of the previous article. The modern concept of a national water grid scheme must be founded on an ex-

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tension of the existing mutual assistance basis, from two different but essentially complementary aspects. 1). An assurance of ample resources and storage capacity should be effected by development of new sources in the Lake District and Wales. Consideration should also be given to other elevated areas as sources. A system of aqueducts would make extra water available in the industrial areas of the North and Midlands. These aqueducts would consist of the cheapest means of moving water in large quantities by means of rivers, streams, cuttings, canals, etc., according to locality, employing gravitational means to the greatest extent feasible. 2). Throughout the remaining parts of the country there exists the possibility of providing much greater reciprocal assistance by a system of "arterial mains" linking up the regrouped undertakings.

"A National Water Grid Scheme-Modern Version." By A. Donald Calthorpe, A.M.I.C.E., A.M.I.W.E. *The Surveyor*, 12 December, 1959.

Other Articles

"Automation of Modern Water Works —How Sophisticated Should It Be?" This article is published because of the incisive evaluation of water works "automation" and the searching check list the author proposes for designers and managers of modern water works facilities. By Richard R. Kennedy, Partner, Kennedy Engineers. Water Works Engineering, January, 1960.

"Know Your **Indicator Organisms."** They may help you evaluate water supply quality and point the way to prevention of water troubles. By James B. Lackey, Professor of Sanitary Science, University of Florida. Water Works Engineering, January, 1960.

"Long Range Planning By Water Utilities." The competent water utility administration is alert to the community's future needs and either plans for or insists on planning for that future. By Ernest W. Steel, Prof. of Civil Eng., Univ. of Texas. Journal A.W.W.A., January, 1960.

"Water Supply Progress in 1959." A comprehensive report on the achievements of 1959 and the problems confronting the water industry in the coming years. By C. F. Wertz, Vice President, American Water Works Ass'n., Water & Sewage Works, January, 1960.

"Progressive Water Works" shows how an **adequate water** supply can help a growing city attract industry. By R. B. Simms, Supt., Spartanburg City and County Water Dept. Water & Sewage Works, January, 1960.

"Ceylon Government's Policy of Piped Water Throughout the Island." Providing for population expected to double in next 20 years. By C. Rosiah, Deputy Director (Waterworks) Ceylon Public Works Dept. and H. C. Husband, Senior Partner, Husband & Co., Consulting Engineers of London, Sheffield and Colombo. The Surveyor, 2 January, 1960.

"Cross-Connection Hazards and Controls." There are more possibilities of cross connection hazards today than ever before. By William D. Shillinger and George G. Fassnacht, Sanitary Engineers of the Indiana State Board of Health. Journal A.W.W.A., January, 1960.

"Safe Water Supplies for Rural New Mexico." The New Mexico Department of Public Health, by act of the Legislature, supervises a program for replacing unsafe water supplies in rural unincorporated communities with safe supplies. By Charles G. Caldwell, M.S.S.E., Director, Environmental Sanitation Services. New Mexico Department of Public Works. PUBLIC WORKS, February, 1960.

• • •

Purdue Industrial Waste Conference

The 15th Industrial Waste Conference will be held at Purdue University, May 3 to 5. Some 50 papers on industrial wastes and their treatment will be presented. More information from Prof. Don E. Bloodgood, School of Civil Engineering, Purdue University, Lafayette, Ind.

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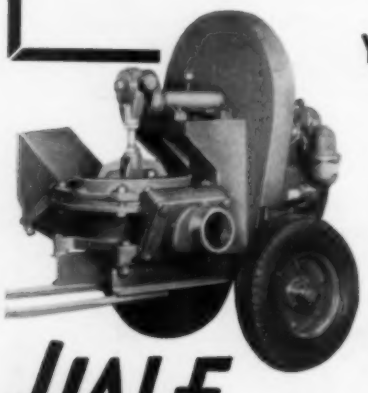

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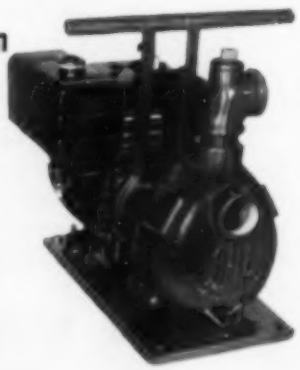

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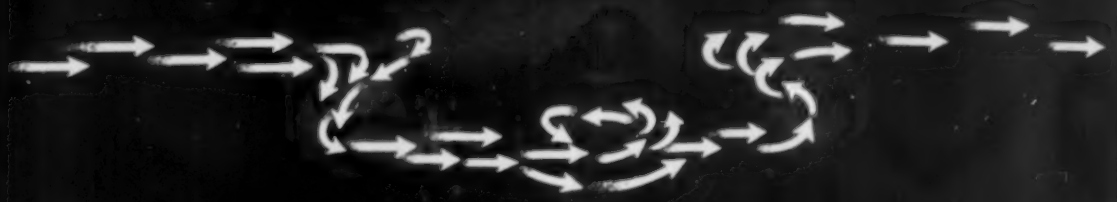

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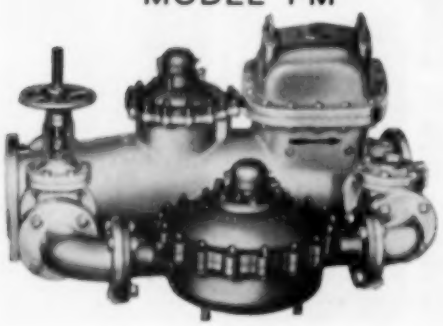

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MANPOWER SURVEY EVALUATES SANITARY ENGINEERING PERSONNEL

Reported by

FRANK A. BUTRICO,
Chief, and

ISRAEL LIGHT,
Information Officer,
Office of Engineering Services,
U. S. Public Health Service

THIS STUDY concerns itself with such manpower factors as age, education, years of service, type of employer, kind of work performed, income, society, affiliations and combinations of these factors, in an attempt to evaluate the needs of sanitary engineers to meet the changes taking place in the field of environmental health.

The definition of sanitary engineer used was that prepared and adopted (as revised) by the National Academy of Sciences-National Research Council in 1954.

The primary source of names was the professional societies membership list. The societies selected represent the engineering profession as a whole, such as the National Society of Professional Engineers; the major specialized areas in which sanitary engineers are employed, such as the American Public Health Association; and groups composed exclusively of sanitary engineers, such as the Conference of State Sanitary Engineers. A total of 14 different society membership lists were used.

Some 10,000 questionnaires were mailed. Usable questionnaires were received from 3,961 respondents. These represent a conservative two-thirds of the estimated total number of sanitary engineers in the country today.

The group is homogeneous to the extent that two specific criteria were employed in determining eligibility for inclusion in this Study. First, the respondent had to have a recognized engineering degree or else be registered or licensed in a State or Territory to practice engineering. Second, he had to consider himself as working in the field of sanitary engineering in one of the following specialties: water supply; sewage and industrial wastes; water pollution control; milk and food sanitation; insect and rodent control; air pollution; refuse disposal; industrial hygiene and occupational health; and radiological health engineering. To be included in this study, one of this list of specialties had to appear among the first three of six the respondent was asked to list.

The bulk of questionnaires were returned between October, 1956, and May, 1957. One follow-up letter brought in a few additional hundred during 1957. Subsequent to the analysis of the almost 4,000 questionnaires, the recheck of membership lists and a sampling of the professional literature uncovered addi-

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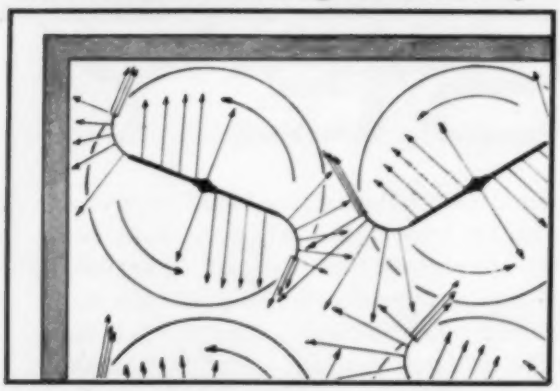

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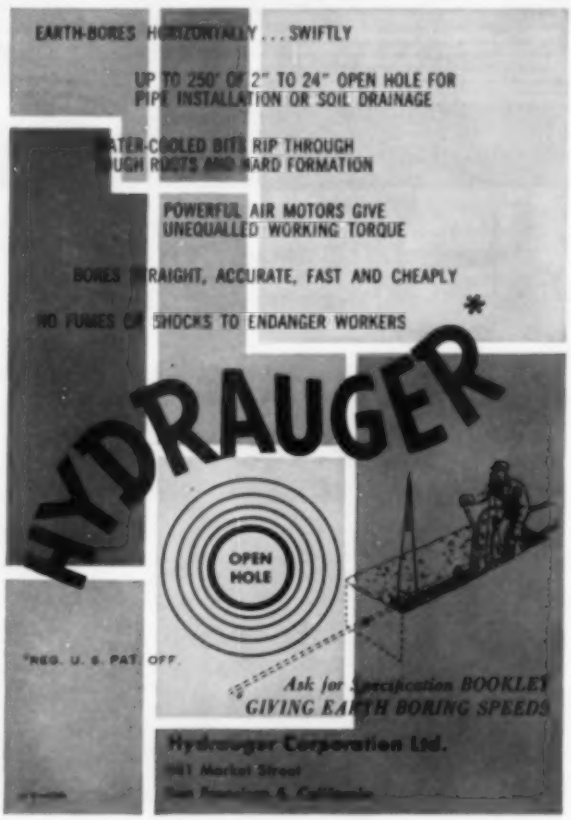
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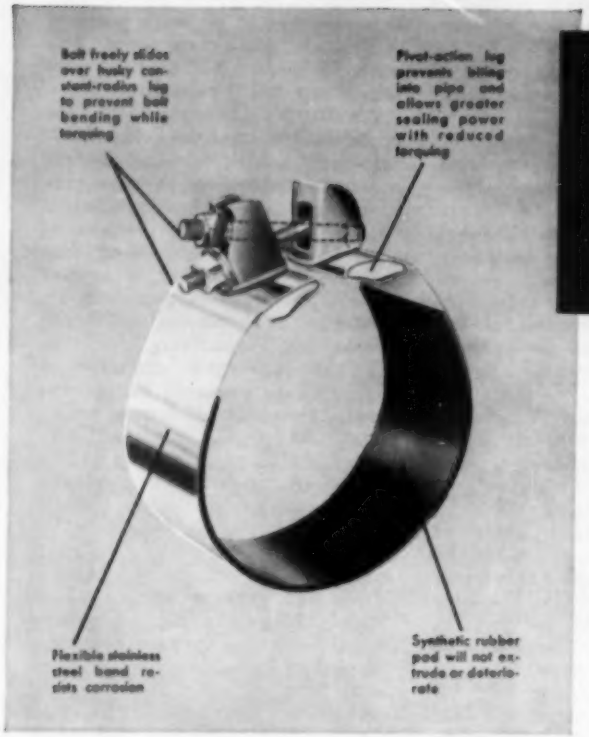
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tional hundreds of sanitary engineers to whom the questionnaire was sent. The replies from 650 were examined, and tentative analysis showed close approximation to the data as revealed by the initial 4,000. In view of the time interval— many of the 650 later questionnaires were received up to two years after the cutoff date for the original 4,000— this latter group of questionnaires was not included in the following analysis.

The approximately 4,000 sanitary engineers surveyed represent two-thirds of the estimated total number of such engineers in the country. The median age of the group was 44.5 years.

About 56 percent have a bachelor's degree, and 40 percent have a graduate degree. Four percent are qualified as engineers through experience rather than by a college education. Of those with a graduate degree, 37 percent have a Master's degree and 3 percent have a Doctor's degree.

About 70 percent (80) of all respondents holding the Doctor's degree, 75 percent (1,052) of those with the Master's degree, and 64 percent (1,385) of those with only the Bachelor's degree were under 50 years of age. The high proportions of those holding graduate degrees reflect the increasing availability of graduate education in sanitary engineering, especially in the last decade.

About 33 percent of the engineers engaged in consulting and more than 40 percent of those in positions of administration or management hold a graduate degree. When grouped by kind of work performed, these two categories represent the oldest in age and those with the most years of professional experience. In view of the relative recency of widely available graduate curricula, these graduate degrees were undoubtedly added to considerable on-the-job experience, and thus reflect an engineering competence blended of rising standards and individual initiative.

Approximately the same number of sanitary engineers are to be found in the under-35 and over-55 age groups. However, at the time of this survey (1956), the replacement factor was not large enough in terms of the increasing attrition rate in the upper age groups and in terms of an engineering specialty which is expanding its area of responsibilities, functions and duties.

About 60 percent of the respondents reported 15 or more years of professional work experience. Another 20 percent had 8-14 years of experience, and 17 percent 4-7 years.

Almost 66 percent of the respondents identified the fields of water supply, waste treatment, and water pollution control as their primary area of academic specialization or major area of professional experience. On the other hand, only 1 percent and half of 1 percent claimed major specialization in air pollution and radiological health engineering, respectively.

Of the surveyed engineers 50 percent were employed by government, 27 percent in business or industry, 15 percent were self-employed and 5 percent were in the field of education. The remaining 3 percent were engaged in miscellaneous activities.

The 50 percent working in government were apportioned as follows: 15.5 percent employed by States, 15.5 percent by municipalities, 8 percent by the Armed Forces, 5.6 percent by the Federal Government (civilian), and 5 percent by county government.

Fully 33 percent of the group were engaged in administration or

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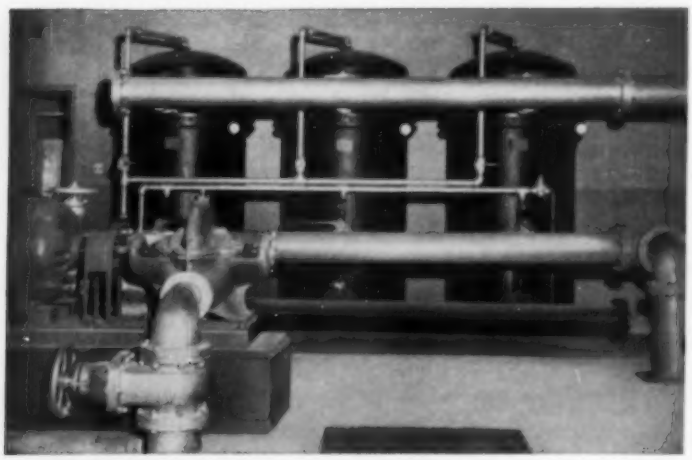

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management of some kind; 27 percent report in private practice or otherwise involved in engineering consultation; 16 percent in development and design work; 16 percent in inspection, production, and sales; and slightly more than seven percent in teaching and/or research.

Median income of the sanitary engineers (from principal employment) was $8,300. This varied, however, by type of employer. Those employed by government received $7,800; in business or industry, $8,700; self-employed, $14,200; and teacher-engineers, $7,200. These figures do not reflect a 10 percent increase in the past two years to Federal employees.

Within government, the following medians were found: municipal, $7,900; county, $7,700; State, $7,100; and Federal, $8,800, not including recent increases.

Only 3,000 of the 4,000 respondents answered the question on additional income from professional services rendered. Of these, about 2,100 (71 percent) reported receiving no such supplemental income. Of the remaining 29 percent reporting some added income, 15 percent received under $1,000, 12 percent received between $1,000 and $5,000, and 2 percent earned more than $5,000.

PROPOSAL FOR COMPOSTING REFUSE SOUGHT BY PHOENIX, ARIZONA

The City of Phoenix, Arizona, has issued an invitation for proposals for an agreement with an individual or corporation for the disposal of garbage and trash utilizing the composting process. Salvage of such items as have resale value will be permitted, and proposals for the destructive distillation or carbonization of tree trunks, tree limbs, and shrubbery in conjunction with a composting operation will be considered. The following points will serve as a guide to anyone interested in submitting a proposal for refuse composting:

1. The City plans to retain garbage and trash collection operations in residential areas. A private company has a franchise to collect refuse in business districts.

2. The composting facilities, including salvage operations, would be constructed with private capital. The City now generates approximately 600 tons of refuse per day. Proposers must certify that they would be able to compost and dispose of at least this amount daily, and the ability to handle 900 tons daily when required.

3. The City would agree to dump the garbage and trash collected by City forces at the composting plants, and would pay the individual or company approximately the amount it now costs the City to operate the landfill. The payment would be computed as a specified sum per ton of refuse hauled and dumped at the plant.

4. Composting facilities must be strategically located insofar as the City's convenience of hauling refuse is concerned.

5. Three composting plant sites not to exceed 10 acres each would be furnished by the City.

6. The City would expect to participate in the gross or net income of the venture.

Further details and a copy of the invitation to submit proposals may be obtained from Ray W. Wilson, City Manager, City Hall, Phoenix, Arizona.

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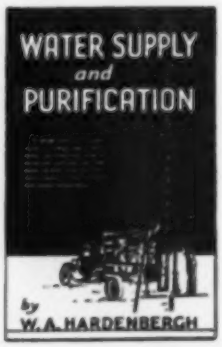

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THE
INDUSTRIAL WASTE DIGEST

Prepared by **CLAYTON H. BILLINGS,** ***Associate Editor***

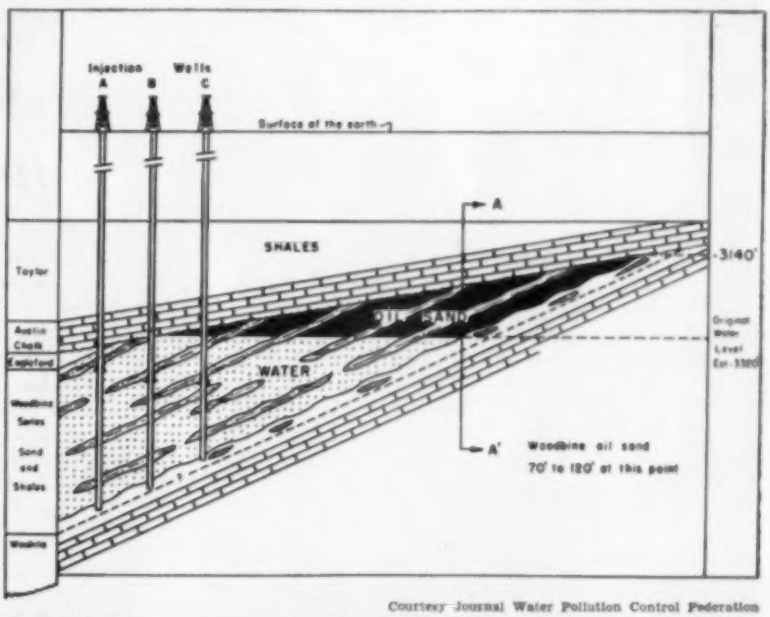
Salt Water Disposal

The East Texas oil field, discovered in 1930, was producing 200,000 barrels per day by 1939. This resulted in an injunction suit aimed at abatement of stream pollution. First attempts at control through storage in earthen pits failed because of the problem of preventing overflow and seepage. In 1942, the oil field operators organized the East Texas Salt Water Disposal Company, incorporated to function as a public utility to develop and to carry out the disposal of salt water produced in the area. The war brought about increased production of oil and focused attention on the need for repressuring the field. The result was the decision to use injection wells for disposal—returning the water to the original producing sand in an area of salt water encroachment. Treatment of the salt water is required to reduce the scale-forming tendencies and other characteristics which would reduce sand porosity. The procedures generally consist of removal of entrained oil by skimming, aeration to oxidize iron and convert bicarbonates to carbonates, chlorination to control algae and bacterial growth, and coagulation to precipitate iron and calcium. Chemical dosages required for coagulation are 8 to 12 lb. of lime and alum each per 1000 barrels of salt water, costing about 0.5 mill per barrel. Sedimentation involves a 24-hour retention period. Removal of floc particles is insufficiently complete by this process, necessitating filtration through anthracite-media pressure filters before injection. A gathering system to centralize operations was also necessary. The Company now has over $6 million invested in 390 miles of pipe lines, 35 treatment plants, 60 injection wells and related equipment.

"Subsurface Disposal of Salt Water from Oil Wells." By W. S. Morris, Vice President and General Manager, East Texas Salt Water Disposal Company. *Journal Water Pollution Control Federation*, January, 1960.

Wood Distillation Wastes

The Wrigley plant of the Tennessee Products and Chemical Corp. near Nashville, Tenn., produces charcoal, acetic acid, wood alcohol, and various wood oils and tars. Wood is converted to charcoal and volatile materials are condensed and later distilled to produce the other products. Refining of alcohol produces "Lime Lee wastes" and "alcoholic pot residues." Refining acetic acid results in "water column wastes" and "decanter overflows." The Lime Lee and water column wastes account for most of the volume, and the decanter overflow wastes are high in phenol and turn black in the presence of dissolved iron. Lagooning with chemical treatment results in varying degrees of improvement of all wastes except the water column wastes with respect to BOD. Spray irrigation disposal methods were investigated by the use of a pilot greenhouse in which different grasses were subjected to varying doses of the waste. It was found that disposal of Lime Lee and water column wastes had little effect on fescue. This prompted the use of a quarter-acre test plot and eventually full scale operation of a 40-acre area. The wastes are fed to a neutralizing sump from which they are pumped to a one-half acre lagoon, adjoining the irri-



Courtesy Journal Water Pollution Control Federation

● **SIMPLIFIED cross-section of East Texas field showing salt water disposal plan.**

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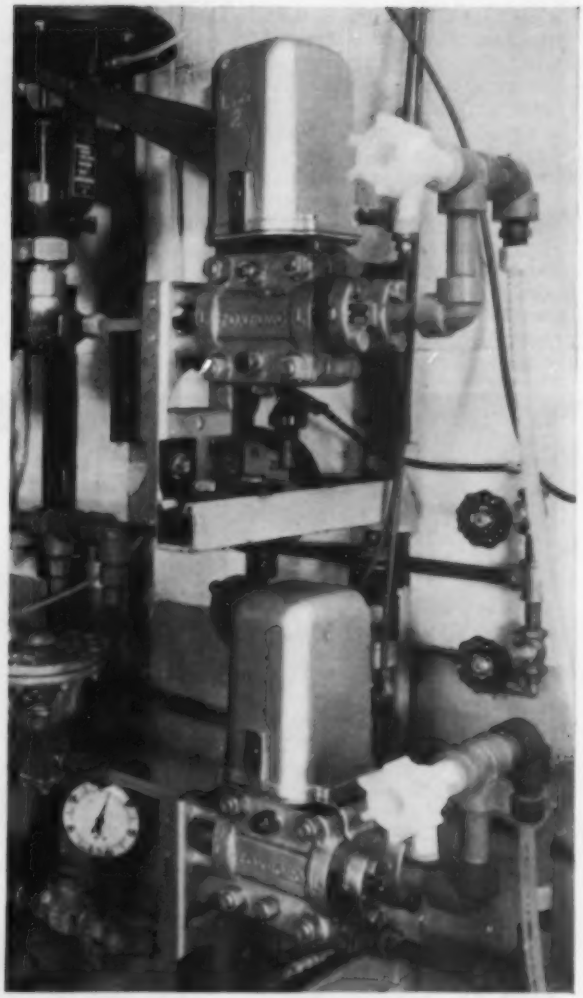

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gation field. Portable aluminum pipe is used for distribution in the irrigation area. The field is covered by a 4-in. distribution header splitting the area into east and west portions. At 60-ft. intervals the header is equipped with quick-coupling fittings. Four movable lateral spray lines are connected to the header at locations chosen by the operator to permit spraying sections of the field in planned sequence. The laterals are 3-in. aluminum pipe fitted with nozzles every 25 ft. The system handles 300 gpm and was installed at a cost of $15,000.

"Spray Irrigation of Wood Distillation Wastes." By R. C. Hickerson and E. K. McMahon, Tennessee Products and Chemical Corp. *Journal Water Pollution Control Federation*, January, 1960.

Oxidizing Brewery Wastes

Batch laboratory experiments were undertaken to evaluate the applicability of aerobic biological methods for removal of organic contaminants present in waste discharges from a brewery. There are thirteen primary sources of waste water in the usual brewery operation, amounting to about 14 gallons per gallon of brew. Since the final composite waste flow is the result of several batch operations, its constituency can vary markedly. Thus the treatment studies were made on varying combinations of the waste streams. Factors evaluated were BOD removal at various sludge solids levels and times of aeration, oxygen demand rates corresponding to varying BOD loadings, sludge production, oxygen transfer characteristics, sludge sedimentation and disposal possibilities, and effect of pH on bio-oxidation efficiency. It was found that all of the waste discharges are amenable to bio-oxidation. BOD reductions in excess of 90 percent can be attained in aeration periods of 3 to 6 hours, and oxidation proceeds over a wide pH range. For concentrations in excess of 150 ppm, the average BOD removal rate was 100 ppm per hour per 1000 ppm of sludge. For concentrations less than 150 ppm, the removal rate was 10 to 16 percent per hour for a sludge solids range of 2,350 to 3,000 ppm. Primary sedimentation may be required. The design parameters developed from the laboratory studies were found to be consistent with results obtained for other organic wastes.

"Bio - oxidation of Brewery Wastes." By W. Eckenfelder, Associate Professor, Manhattan College. *Papers Presented at Sixth Ontario Industrial Waste Conference*, June, 1959.

Evaluating Soils for Spray Irrigation

Successful spray irrigation systems result when the soil is level, absorbs large quantities of water, supports vegetation and drains freely. A soils map may be obtained in some cases which would describe the suitability of a soil for spray irrigation. Most suitable types are sandy, silt and some clay loams. Soil properties that lend themselves to measurement in the laboratory are infiltration (getting the water into the soil), permeability (getting the water through the soil), and storage capacity. The infiltration rate is enhanced by vegetative growth and extensive root systems. Spraying on bare soils will not achieve the degree of absorption usually required. Transpiration is the key process in the utilization of water by plants. Since it encompasses removal of water from the depth of root penetration, evapo-transpiration of vegetation is usually superior to evaporation from bare soil in water removal. Proper management of an irrigation

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area implies maintenance of adequate soil fertility, correction of soil pH, and clipping or mowing. Intermittent application is also important. The off-period should be 5 to 8 days for a clay soil that had received 3 to 5 inches of waterspray plus rainfall.

"Evaluating a Soil for the Disposal of Wastes by Spray Irrigation." By L. R. Webber, Associate Professor Ontario Agricultural College. *Papers Presented at Sixth Ontario Industrial Waste Conference*, June, 1959.

Continuous Removal Of Phenolic Wastes

The unit operations most applicable to a continuous process of phenol reduction to concentrations suitable for stream discharge are (1) countercurrent solvent extraction, (2) adsorption by bituminous coal or lignite followed by flotation, and (3) biological oxidation. Either (1) or (2) should usually be combined with (3) to achieve final effluents of 1 ppm phenol, depending on the initial concentration of the waste. Process (1) will reduce a concentration of 2000 ppm to 50 ppm; (2) will reduce 500 ppm to 20 ppm, but is limited in use to areas where powdered coal can be obtained locally. For solvent extraction, the Turbo-Mixer rotating disc contactor has proven efficient in full-scale industrial installations. Choice of solvent is influenced by the need for a specific gravity difference, immiscibility and method of recovery of phenol from the solvent. In the Turbo-Mixer RDC, extraction can be obtained with a specific gravity difference as low as 0.03. Before secondary treatment by oxidation can be successfully accomplished, the phenol content of the pretreated waste should be determined. In continuous treatment, a continuous flow monitor is required. A type of monitor available uses a potentiometer actuated by a photoelectric cell which reacts to colors developed in samples automatically treated with Millon's reagent. With Air-O-Line control, the unit can be used to operate motorized valves to admit oxidizing agents to the treatment system, to regulate dilution water or even to bypass secondary treatment if the concentration is acceptable. In using bio-oxidation processes for phenols, high rate trickling filters appear to be most adequate; but nutrients must be added; the waste neutralized; flow must be equalized; and the filter should be seeded with sewage sludge or with mixed cultures of phenol-resistant aerobic organisms.

"Continuous Treatment of High Phenolic Wastes." By G. Gutzeit, Associate Director of Research and Development, General American Transportation Corp. *Papers Presented at Sixth Ontario Industrial Waste Conference*, June, 1959.

Other Articles

"Treatment Facilities for the **Photoengraving** Industry." By Wayne A. O'Shana, Industrial Waste Inspector, Los Angeles Sewer Maintenance Section. The problem is principally one of neutralization of nitric acid in once or twice-daily dumps. Journal Water Pollution Control Federation, January, 1960.

"Incinerator for **Radioactive Residue.**" By W. D. McNeese and W. J. Maramon, Los Alamos Scientific Laboratory. A batch type incinerator was built to dry and burn 12 liters of wet, packed rags or the equivalent in about 8 hours. Industrial and Engineering Chemistry, February, 1960.

• • •

European Course in Sanitary Engineering

A European Course in Sanitary Engineering is being organized by the Technological University at Delft and the Netherlands Universities Foundation for International Co-operation (NUFFIC), with the assistance of the Organization for European Economic Co-operation (Paris) and the World Health Organization (Copenhagen). The Course will be held from October 19, 1960, to September 14, 1961.

Instruction will be in the English language. It comprises lectures, practical laboratory courses, group discussions, design exercises, as well as a number of excursions to interesting sanitary works in Western Europe. The faculty will consist of experts from different European countries. A number of institutions in different European countries will also collaborate in the course. Thus it is hoped to train truly European engineers. At the end of the Course diplomas will be awarded to those participants who will have obtained sufficient results according to the Faculty Committee.

The tuition fee for the Course is about $500. Closing date for applications: July 31st, 1960. Further particulars from NUFFIC, 27, Molenstraat, The Hague, The Netherlands.

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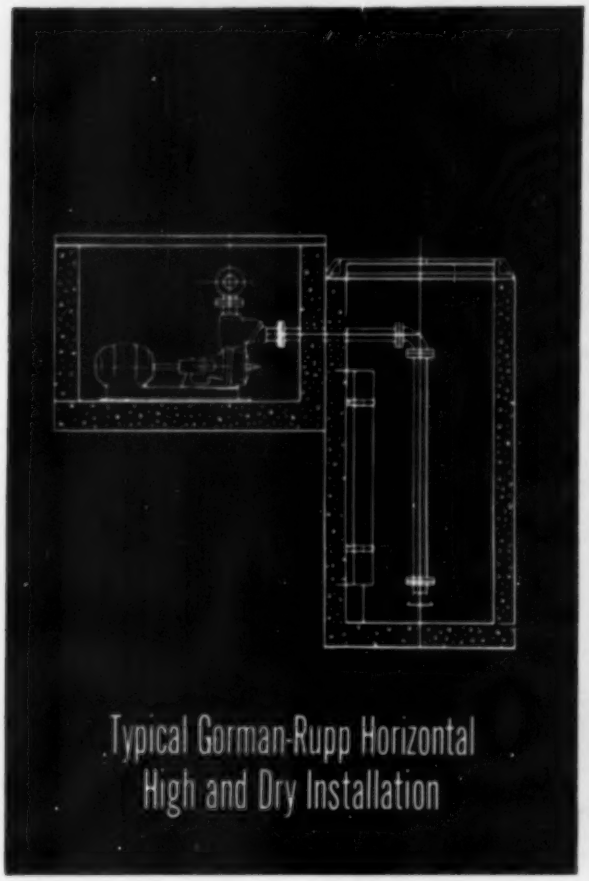
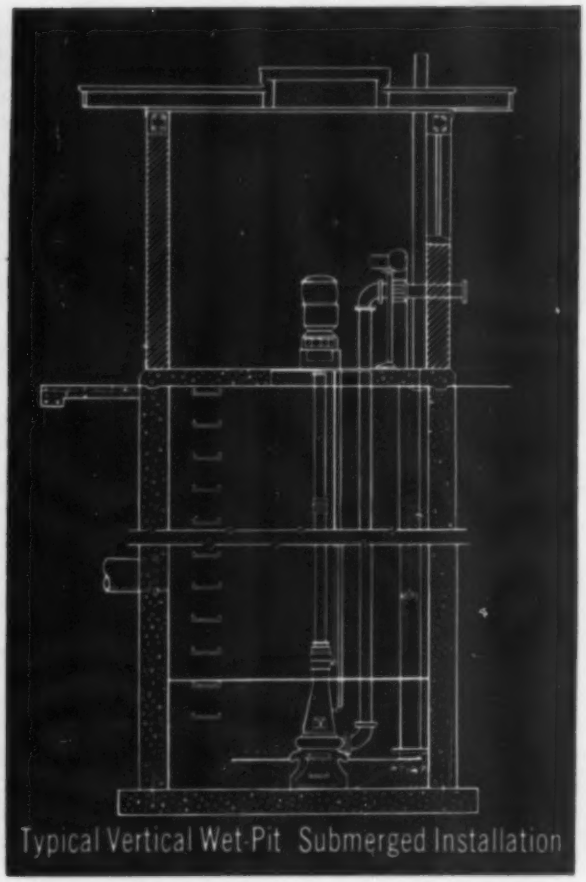


Typical Gorman-Rupp Horizontal High and Dry Installation



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Need for New Rating Criteria for Pneumatic Rollers

H. A. RADZIKOWSKI
Chief, Division of Development, Office of Operations, Bureau of Public Roads

IN GENERAL, there are two broad requirements which should be considered in the compaction problem: 1) the highway requirements, and 2) the equipment requirements.

Before getting into a detailed discussion on the problem of rating pneumatic rollers I would like to outline the present status of highway department requirements for the compaction of embankments, base courses and flexible pavements. These requirements have a considerable effect on compaction equipment designs. Multi-purpose characteristics of a roller may make it feasible to utilize one machine for the compaction of embankments as well as base and surface course.

Highway Construction Requirements

Embankments—At the present time all of the 50 State highway departments and those of Puerto Rico and the District of Columbia require a minimum density for embankments compacted by controlled methods. Forty-five departments base their density requirements on a percentage of the values obtained in AASHO T-99. Four departments base their density requirements on AASHO T-180 which is a modification of the original Proctor Test and AASHO T-99 and requires a higher degree of densification of the embankment than AASHO T-99. Three departments base their embankment density requirements on their own test procedures.

On the face of the record, acceptance by 45 State highway departments of a standard method for testing embankment supporting value would promote uniformity of requirements. However, on examining the ranges of percentages specified and other modifying requirements, it becomes apparent that there is lack of agreement on common denominators and even in basic concepts of soil behavior under highway loads and prevailing weather conditions.

About one-third of the States specify a percentage of 95 based on AASHO T-99 for all soils without any qualifying provisions, and another 4 States specify 90 percent for all soil conditions. The four States which employ AASHO T-180 specify 100 percent for all soil types. There is some question if the same degree of supporting value is expressed when a single percentage such as 95 is specified for both fine grain and coarse grain soils. To illustrate, 18 States favor sliding density requirements, such as 90 to 95 percent or 95 to 100 percent, based on soil classification. Here again there is no unanimity of opinion as to whether the range should ascend or descend as the soils change from coarse grain to fine grain. Twelve States increase the percentage of maximum density as the soils become finer, apparently on the basis that the soils with the least bearing power need the most compaction. Six States increase the percentage of maximum density as the soils become coarser with the thought that granular material will settle under traffic vibration if not compacted to a high degree and over-compacted fine grain soils will swell when subjected to additional moisture. Such major differences in basic concepts should be resolved.

Soil Type Base Courses—Analysis discloses that only about one-half of the States have adopted the standard AASHO density tests for base courses with 26 States specifying AASHO T-99 and one State specifying AASHO T-180. Four States specify other methods of obtaining density requirements. The remaining 21 States either have no density test requirements or leave the method to the discretion of the engineer, all of which can contribute to an even greater variance in end results.

Of the 26 States specifying AASHO T-99, 15 States require 100 percent of maximum density, 7 States require 95 percent and the remaining States' requirements vary from 90 to 105 percent.

The States recognize the inadequacies of the current test methods and would like to have better ones.

Asphaltic Concrete Pavements—Slightly over half of the States have density requirements for the asphaltic concrete type of flexible pavements. Other States determine the acceptability of the finished product on procedures or the judgment of the engineer. Here again the States' construction specifications do not refer to the same density. Fifteen States relate their requirement to a percentage of theoretical density or a voidless mixture. Fourteen States base their pavement density requirement on a percentage of the density of a laboratory mix. The laboratory mix may be designed by at least three methods: the Marshall method, the Hubbard-Field Method or the Hveem Method.

The range of requirements based on theoretical density varies from 85 percent for binder courses to 99 percent for surface courses. The range of requirements based on the density of a laboratory mix varies from 92 to 98 percent. Even when variance in mixes and placing temperatures are considered, both ranges appear to be excessive for wearing courses which are to be subjected to comparable truck tire loads. Based on our present knowledge, a range of 95 to 98 percent of laboratory density seems to be a desirable degree of compaction for asphaltic concrete surfaces.

Equipment Requirements

Embankments—Approximately 80 percent of the States have specific equipment requirements in that the type of equipment used to obtain a required density is specified in considerable detail. The remaining States operate on an "end result" requirement by which the contractor may use any type of equipment which will produce the specified density. The following is typical of such end result requirements: "The contractor may use any type of compaction equipment he deems necessary to obtain the specified density."

In this discussion it should be sufficient to point out that there is a considerable variance in the capacities of steel wheel and tamping rollers used in embankment compaction.

Practically all States allow the

This article is based on a talk by Mr. Radzikowski at a meeting on "Compaction Equipment Requirements for Asphalt Pavements" held in Washington with tire and equipment manufacturers and others interested in these problems.

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use of pneumatic rollers in embankment compaction with 7 States permitting their use when approved by the engineer. While minimum and maximum width, number of axles and minimum number of wheels are sometimes specified, there are at least four methods now in use in expressing the compacting ability of pneumatic rollers. These are: Gross weight of vehicle; Wheel or tire load; Weight per inch of tire width; and Tire inflation pressure.

Five States rate pneumatic rollers on the basis of gross weight with one State requiring 5 tons, two States requiring 8 tons, one State 10 tons and another 30 tons. Gross weight ratings are meaningless unless the number of wheels, tire size and inflation pressure are known.

Seven States specify minimum or ranges of wheel loads of 1,000 to 6,000 lbs. but these do not express compacting ability unless the tire size and inflation pressure are known. Wheel loads within a range of 1000 to 2500 pounds, even when used with the smallest compactor tire now available, will not produce the compactive effort needed in modern highway construction.

Seventeen States rate the required pneumatic rollers by "weight per inch of tire width" but the overall variance between minimum and maximum requirement is 1300 percent.

While the "weight per inch of tire width" when applied to steel wheel rollers gives a representative measure of compacting ability, the same criterion loses much of its significance when applied to pneumatic tires. In the case of the steel wheel rollers, a uniform rectangular contact pattern exists under most conditions. On the other hand, the oval contact pattern produced by a tire changes as wheel loads and inflation pressures are varied. In general, the tire contact length changes to a greater degree than the tire contact width as the inflation pressure and wheel load are varied. If the weight per inch of tire widths are converted into wheel loads at various inflation pressures, a sizeable range in contact pressure results. For example, a 10.00 x 15 12-ply tire exerts an average contact pressure of 60.4 psi for a wheel load of 5000 pounds when inflated to 55 psi. If the wheel load is kept at 5000 pounds and the inflation increased to 100 psi, the average contact or ground pressure increases to 87.2 psi.

Several States specify the tire inflation pressure. This is of limited significance without tire size and wheel load. Contrary to popular belief, inflation pressure and contact pressure are not necessarily synonymous.

Last year in developing special provisions for test rolling with a heavy pneumatic compactor, the Michigan State Highway Department took cognizance of the need for better criteria in rating the compacting ability of pneumatic rollers. The following is quoted from the special provision: "The contractor shall furnish to the engineer, charts or tabulations showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the tire furnished."

When such values are related to compacting performance on different types of soils under varying moisture conditions, it will provide the type of information needed to eliminate detailed equipment requirements in compaction specifications.

Soil Base Courses—The variance in equipment requirements for soil base courses is quite similar to the variables mentioned for embankments except that only a few States

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operate on an "end result" criteria with greater dependence placed on the judgment of the engineer. There seems to be a trend toward the use of high pressure pneumatic rolling of base courses, particularly the stabilized types and other designs which contain fine grain materials.

Pneumatic rollers are now required in about one-fourth of the States for compacting asphaltic concrete and may be required in several others when directed by the engineer. They are permitted in another 9 States when approved by the engineer, but are are not permitted in about half of the States. In those States which require or permit pneumatic rollers for compacting asphaltic concrete, the equipment requirement, with one or two exceptions, results in contact pressures which are far less than those which are imposed by heavy trucks. For example, wheel loads of 1,000 to 1,400 pounds, as now specified for pneumatic rollers, are no more than can be expected from the lighter passenger cars now using our highways. As in the case of pneumatic rollers specified for embankment compaction, the equipment capacity criteria used—wheel loads, weight per inch of tire width, inflation pressure, etc.—are not only meaningless in expressing compacting ability but, in addition, they are often combined with other requirements which make the equipment specifications restrictive to many manufacturers.

In order better to express compacting ability and to assure against the use of restrictive equipment requirements in construction specifications, it is our belief that "ground pressure" or tire contact pressure should be the principal criteria for rating pneumatic rollers. Only in the last several years has it been recognized that the average ground pressure exerted by pneumatic tires is not limited to or necessarily equal to tire inflation pressure.

It can be seen from the foregoing analysis of compacting equipment requirements that there is a marked lack of uniformity. This fact hampers both the highway contractor who operates over State lines and the equipment manufacturer who must design for these multitudinous requirements. One equipment manufacturer recently advised our office that current compaction equipment requirements, of the highway departments necessitate the manufacture of 22 models; and it was believed this number could be reduced by two-thirds with proper standardization.

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TEN YEARS EXPERIENCE WITH A SEWER SERVICE CHARGE

CLARENCE EIDSON
City Manager,
Waycross, Georgia

THROUGH THE USE of a sewer service charge, which has been in effect for over ten years, the City of Waycross, Georgia, has been able to finance many improvements in its utility system. A new sewage treatment plant is under construction, and water and sewer lines have been extended into areas which heretofore could not be reached. In this city of 22,500 population the charge is generally considered fair to all and is accepted as a utility bill.

Ten years ago the city had about 1000 open privies in the poorer section of town. These were endangering the health of the community. Raw sewage was being dumped into the Satilla river on the outskirts of town, contaminating it for miles. Fishermen—and Waycross is full of them—complained that fish caught in the polluted waters of the Satilla reeked of oil which commerce allowed to pollute the stream. When fried, the fish tasted strongly of kerosene.

For many years the City Commission considered building a sewage treatment plant, but the cost was so great that it did not seem feasible. A sewer service charge to help finance the building of sewers and a treatment plant appeared to be the solution. Improvements like this would put the Health Department in a position to force the removal of the outhouses, and it would clear up the river. Such a charge had wonderful possibilities, indeed, if the rates could be made fair and acceptable to the public. The following proposals were considered:

1. A flat rate charge to each customer. This was soon discarded because some consumers would receive more benefits from it than others.

2. A rate charge based on the number of plumbing fixtures. This seemed too complicated to keep current.

3. A charge based on the quantity of water used. This was simple to administer, but was it fair?

It was believed that those citizens who used the water but not the sewers would protest, so efforts were made to find these consumers and charge them for water only. In addition there were customers who used a lot of water, some of which did not flow back into the sewer, such as soft drink manufacturers, ice plants, and cooling tower operators. However, a detailed study showed that only a nominal number of users fell in this class.

The real heavyweight contender for first place in this argument for service not rendered was the man who watered his lawn a great deal and maintained that he should not have to pay for service on water used this way. His monthly bill might be $3.00 in the winter and $15.00 in the summer. About the only way the Commission would justify his increased bill was for the city to go to the expense of installing water mains large enough to satisfy his summer demand. This investment would be paid for by large consumers like him. The Commission reasoned, however, that they are well able to pay excessive rates or they would not be watering their lawns.

● **SEWAGE** treatment plant under construction. Author is at left foreground with Earl Tapley of Dixie Concrete. Engineers are Wiedeman & Singleton. Livsey & Co., contractors.

Table 1—Sewer Service Charge in Waycross, Georgia
(Applicable only when City Sanitary Sewer is used)

Water Bill Amount of Gross Per Month		*Amount of Sewer Service Charge Per Month*
Minimum to	$2.00	$ .75
$2.01 to	3.00	1.00
3.01 to	5.00	1.25
5.01 to	10.00	1.50
10.01 and	over	$.75 plus 10% of Water Bill
Laundries and Packing Plants		20% of Water Bill

As few inequities were seen in this basis of charge, the rate schedule outlined in Table 1 was adopted. There was no need to fix special minimum charges for industrial accounts, as they were predetermined by the water rate.

A chart setting forth the rate schedule accompanied the first bill for sewer service. The bill itself is an item on a post card sent to householders and other consumers. This lists Water Only, Sewer Service Charge, Other Charges, and Total Amount Due. (The "Other Charges" meant "arrears," but could not be so shown because of Post Office regulations.)

Our billing machine printed the original, which was mailed, and a carbon copy to be kept in the office file. After the first bills were mailed, we were surprised to get few comments on the new charge. But, as may be expected, there were some unforeseen questions, like these:

Question: I rent from Mr. Jay. He should pay for the sewer. May I pay for the water only?

Answer: The bill must be paid in full. Who pays it is immaterial.

Question: We have a septic tank. Why should we pay for the sewer?

Answer: We will send a man out to verify our records. If he reports that your plumbing is not connected to the city sewer, you will not be charged for this service.

Question: Now that I am paying for the sewer, will you clean the house service line when it stops up?

Answer: No.

A good working relationship had been cultivated with the local Health Department. Through their office numerous articles had been published in the Waycross *Journal-Herald* describing the need of improvements in the sewer system. These articles emphasized that the necessity for extending the sewer system was not for the convenience of the public so much as it was for the protection of the general health of the city.

It stressed further that the areas most in need of sewers were the crowded and blighted sections of town which could not afford to have the property assessed for the improvements. Also it was pointed out that it was most likely that an epidemic would start in these unhealthy areas and spread to the choice residential sections of town.

In the follow-up stories about the danger of an epidemic, the Health Department listed diseases caused by open privies and described how flies and other insects carry germs. Naturally, most literate people found these valid reasons for improvement of the sewer system.

When the public first heard of the sewer service charge, the reaction was normal—"Just another scheme to gouge a dollar out of the taxpayer." But as more facts were shown in the paper about the hazards of privy areas, public resistance lessened.

Clerks at the City Hall were well instructed on the basis of a sewer service charge and on the improvements it could bring. They were trained to meet public complaints with tact and practical answers.

Prior to the first billing, clerks did their best to sell the merits of this project to each citizen who brought up the subject. And consumers who first voiced their grievances or gave the clerks the benefit of their thinking as to how the project should be handled were listened to patiently. Whenever possible they were agreed with and allowed to go their way feeling that they had made a contribution. Other small-talk complainers could usually be convinced that the charge was fair. The psychological effect of the clerks' work cannot be minimized.

After the first billing the job of these city servants changed auto-

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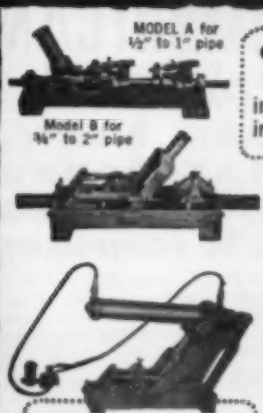

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Table 2—Summary of Revenue

	No. of Water Customers	No. of Sewer Service Customers	Revenue Water Only	Revenue Sewer Service Only	Total Revenue
1948.....	3653	2722	$93,210	$29,200	$122,410
1949.....	3784	2931	95,494	31,670	127,164
1950.....	4034	3038	101,511	33,166	134,677
1951.....	4234	3294	110,690	34,502	145,192
1952.....	4428	3465	118,684	35,256	153,940
1953.....	4606	3739	125,437	39,397	164,834
1954.....	4771	3850	143,142	45,452	188,594
1955.....	4934	4078	164,519	50,981	215,500
1956.....	5028	4184	172,718	54,653	227,371
1957.....	5177	4331	169,812	53,584	223,396
1958	5206	4368	185,433	85,142	270,575
1959.....	5312	4484	196,980	90,234	287,214

matically from selling the idea of a new sewer service charge to explaining fluctuating rates from month to month. The clerks did such a good job that customers realized that the charge was permanent and accepted the fact philosophically. They started paying without protest after the initial orientation period. Only occasionally would somebody leave the office disgruntled. And not a single threat of legal action has been made since the charge was instituted.

As a result of the sewer service charge and efforts of the Waycross and Ware County Health Departments, sanitation in the city has been materially improved. Since 1948, approximately 700 open privies, almost all that were within the city limits, have been eliminated. Nearly 2000 new sewer connections have been made. Over 18 miles of new sewers and 25 miles of new water mains have been installed.

Construction of a sewage treatment plant was delayed, but this project finally was started in September, 1959. As a result of the delay the required capacity of the plant was nearly doubled from previous estimates. The plant now under construction will give complete treatment for 3½ MGD. To finance these improvements a revenue bond issue of over $1 million was sold in 1959.

In Table 2 a summary of rates for 1948-1957 shows revenue realized by sewer charges. The average householder pays roughly $4.50 monthly for water and sewer service. Waycross has so few industries that they do not contribute material to the total revenue.

Other cities that need additional revenue could well follow the example of the Center City of South Georgia and get a plan underway for a sewer service charge.

• • •

Daily and Monthly Use of Water

The maximum monthly use of water in Portland, Ore., during the fiscal year ending June 30, 1959, was 4,306 million gallons. This use occurred in July, 1958, and was 2.4 times the minimum month, February, 1959, when consumption was 1,792 million gallons. The maximum day, July, 29, showed a usage of 204 million gallons which was 3.6 times the minimum day, Feb. 8, when usage was 60 million gallons. Average consumption was 121 gpcd.

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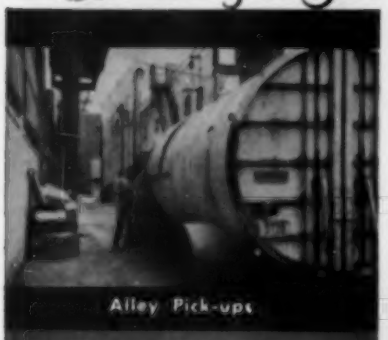

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Hydraulic Dredging Aids FLOOD PREVENTION PROGRAM

O. E. SIMMONS,
Manager,
Palo Verde Irrigation District,
Blythe, California

A PROGRAM to prevent possible flood threats in California's Palo Verde Irrigation District involves hydraulic dredging. No connecting waterways exist, and since the areas requiring silt removal are many miles apart, a dredge with portable features was needed.

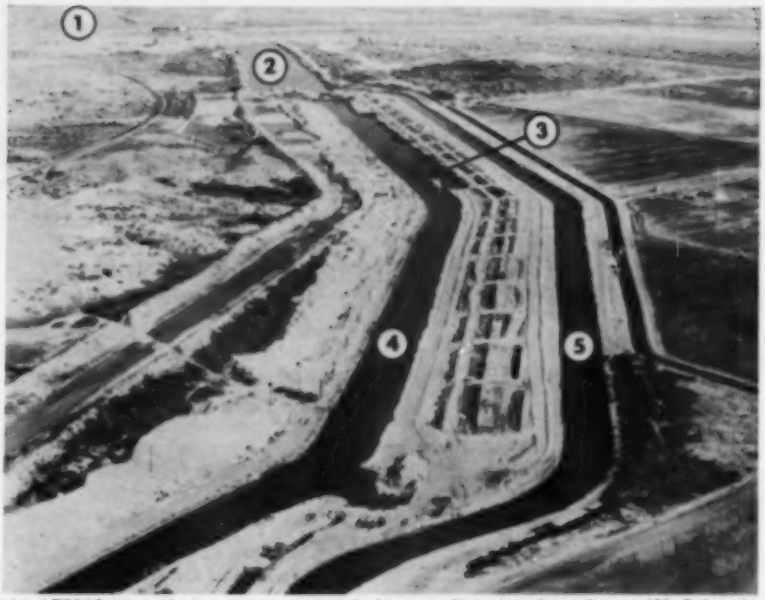
The PVID system serves 180 square miles of land extending 35 miles along the west bank of the Colorado River in the eastern end of Riverside County to a depth of from 2 to 10 miles. More than 310 miles of irrigation canals and over 100 miles of drainage canals provide and dispose of water used for irrigating the 120,000 acres, three quarters of which is under cultivation.

The control system involves an intake canal, settling basin, main canal and a vast network of small irrigation and drainage canals. Water from the river is drawn off through the intake canal. Sand and silt from the river are siphoned off as the water passes through the settling basin into the connecting main canal, feeding the network of smaller irrigation canals.

A series of smaller or lateral drainage canals drain and convey the water back into the Colorado, completing the circuit. Interruption of this circuit could mean flood or drought.

In recent years, a high ground water condition has developed, caused primarily by extensive irrigation. Water released from the dams increased the amount of sand and silt deposited in the settling basin, lagoon and canals. Outfall drains have become inadequate to handle this new drainage problem.

The Valley's soil consists mainly of recent alluvial deposits (a combination of soil, sand, gravel and similar detrital material left by running water) resulting from recurring overflow from the river. It is of a fine texture which is a deterrent to subsoil drainage. With continued ground water build-up the lower valley area could become waterlogged.



● **AERIAL view during construction of the new diversion dam shows: (1) Colorado River; (2) the settling basin; (3) dredge "O. P. Calloway" widening Main Canal (4). After completion of the Main Canal the Duplicate Main Canal (5) was eliminated.**

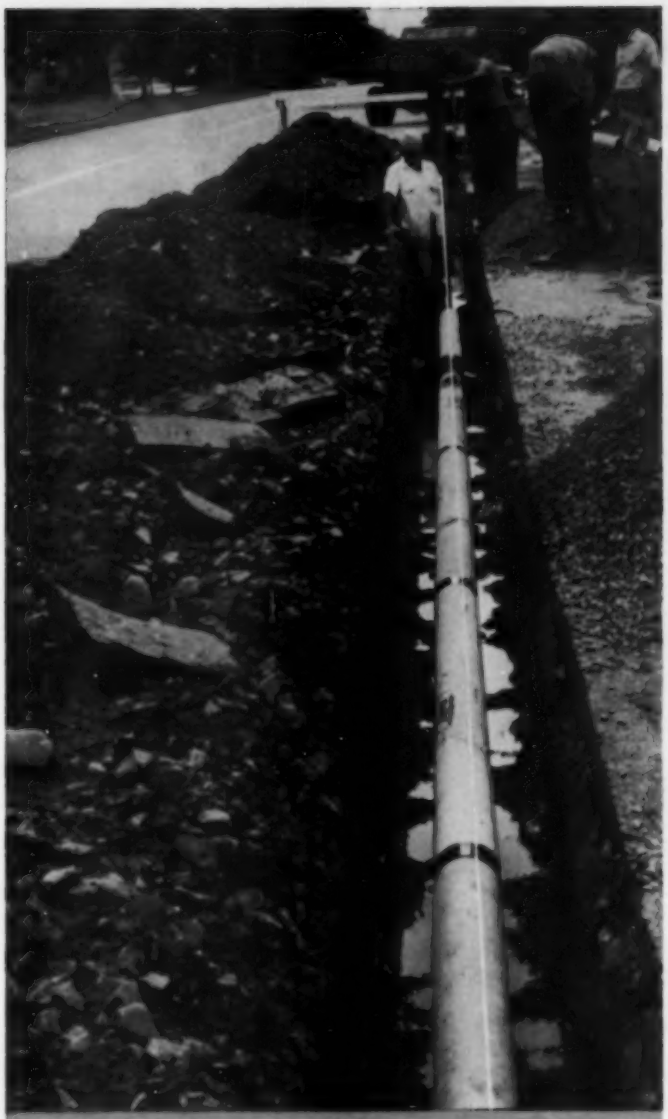
To prevent any such possibility, PVID decided on an extensive and continuing three-phase program to relieve this threat: First, thirty percent (30 miles) of the outfall drainage canals had to be widened, deepened, desilted and straightened; second, Palo Verde Lagoon had to be dredged and spoil material transported about 4,000 feet where it would be used to fill existing slough areas for later cultivation; and third, sand and silt had to be periodically removed from the settling basin at the foot of the intake canal.

These work areas were from 30 to 40 miles apart. The lack of connecting waterways between them posed a major problem.

Selecting a dredge involved finding one compact enough to operate effectively in the more limited areas of the small outfall drainage canals, yet versatile and with sufficient capacity to handle the settling basin and lagoon work efficiently. Primary consideration had to be given to its portability. The dredge would have to be transported by low-bed trailer over state and county highways as easily and quickly as practical.

The unit selected was a 10-in. "Dragon" model portable hydraulic pipeline dredge specifically designed and manufactured for PVID by the Ellicott Machine Corp., of Baltimore, Md. It is a wholly self-contained unit with a total rated output of 240 cu. yds. of waterborne solids per hour. It can pump through pipelines up to 4,000 ft. long. The maximum total connected horsepower of the diesels driving the Ellicott pump, hauling and hoisting machinery, cutter and electric generator is 375 hp. Maximum digging depth is 20 ft. Its hull, 44 ft. long, 18 ft. wide and 4 ft. deep, is designed in match-marked parts for easy disassembly, transportation and field assembly.

Launched at the settling basin three months ago, the new dredge is named the "Palo Verde." PVID officials are now confident that the farmers of the Palo Verde Valley can look forward to relief from the problems that have caused much concern in the past.



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10	1,100	13
12	1,200	13

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Practices in Financing Storm Drainage

Survey of storm drain financing practices brings pertinent and interesting comments from a number of cities and shows the variety of local problems.

IN COOPERATION with interested city engineers, several questions were asked on our 1959 City Engineering questionnaire in order to clarify certain practices in respect to storm drainage. Returns from the questionnaire number 1563, but the data herewith are from the first 996 returns. The processing of the questionnaires and of the numerous notes and letters attached to them has required considerable time.

The first question was: If financing is by assessment, how do you determine the measure of benefits to the property owner? The answers to this are covered more fully in the comments which follow, but 82 cities reported using an area basis and 38 reported using some other method; 16 of these specifically stated that front-foot measurement was used.

To the question: Do you use different methods for determining benefits for storm and for sanitary sewers? 193 cities said they did and 127 reported they did not. Again, the comments which follow cover this problem in more detail.

A third question covers a common problem: Is the benefit for a storm sewer the same for property on a hill as for property in a valley? Most people agree it is; the vote was 182 to 35.

The next two questions were not properly worded to get full information. One asked: Are private properties required to connect to the storm sewer; and may property owners discharge water into the street? The answers to the first was 158 yes and 357 no; to the second 413 yes and 115 no. Obviously, this question should have drawn a distinction between one and two-family premises, where only rain water flows into the street, and premises having a continuous flow of air conditioning water or other wastes or drainage from a large roof area.

Selected comments from a number of cities follow. These are useful in highlighting various local problems and in illustrating the general sound approach by engineers to this costly problem of storm drainage.

Mountain Brook, Ala.—Storm sewers are financed in several ways. The most usual method is for the developers of the subdivision to pay for the construction of storm drainage required by the City. A second method of financing is for the property owners who may be benefited by the drainage to make voluntary contributions for about 50% of the cost and the City to pay the additional cost from the general fund. In some cases where the drainage affects a great many property owners, the City pays the entire cost from its general fund.

Property owners are permitted to discharge storm water into the street provided there is no storm sewer available to connect to or if the storm sewer is in the street.

Mountain Brook has storm sewer plans for the most urgent areas of the City; some lines have been constructed and some not constructed. Because of the financial problems involved the City has finished only a portion of the planned sewers, estimated cost of which at the time (1946) was $1,500,000.00.—G. M. Ellison, City Clerk.

Phoenix, Ariz.—Storm sewers are financed through a combination of general obligation bonds and special assessments. The city pays for large trunk and interceptor storm sewers with funds received from general obligation bond issues. Smaller connecting lines are paid for by property owners through special assessments.

Property owners on storm sewers are assessed according to front footage of their lot. For sanitary sewers, the property owners are assessed according to a formula which takes into account odd shaped lots.

Our city has few homes located on hills within the city limits, therefore, the question regarding assessments against property on a hill is not applicable in our case.

Property owners are not required to connect to storm sewers. Although Phoenix is now engaged in a storm sewer construction program, there are still few storm sewers in comparison with other cities in the United States. Even when a relatively heavy rainfall occurs, much of the water soaks into the dry soil and does not find its way into the street.—Marvin Andrews, Administrative Analyst.

North Little Rock, Ark.—Storm sewers are usually financed under the improvement district plan. A board of commissioners is appointed, the members of which are owners of property within the boundaries of the district. This Board appoints the engineer, attorney and assessor. Assessments are made against the property on the basis of benefits received. The Commissioners, not the City, administer the affairs of the District. Improvement is financed by bond issue.

At the present there are six projects under way for the subdividing into lots of approximately 126 acres. The developers install all sanitary and storm sewers, construct all paving and sidewalks and install street lights, subject to the City Subdivisions Regulations.—Glenn D. Douglass, City Engineer.

West Memphis, Ark.—Storm sewers are assessed by districts. Since we have no hills, the cost is prorated and assessed against all property on a footage basis, i.e. assessment for a 100-ft. lot is twice that for a 50-ft. lot; financing is by bond issue, combined with street improvements.—James M. Howell, City Engr.

Culver City, Calif.—Storm sewers in Culver City were financed by WPA and other federal funds until recent times. Subdividers were required to construct storm sewers affecting their subdivision at their own cost. Currently, storm sewers are being financed by County-wide general obligation bonds.

The City Engineer's opinion is that the benefit of storm sewers in any area, whether hill or valley, would be the same for the reason that an owner of hillside property may have to traverse the streets in the valley which, if subject to flooding, may cause damage and inconvenience to him and his property to the same degree as for the owner of property in the valley. However, if a storm sewer in the valley is designed to protect valley property from flooding, it would certainly be of more benefit to that property than to hillside property. Private properties are not required to connect to the storm sewer as a general rule. Usually they connect to a storm sewer when necessary and

available. Property owners may discharge storm water into the street. —Deane Seeger, Chief Administrative Officer.

Garden Grove, Calif.—The City at the present time is in the process of formulating a master plan for storm drainage. It is estimated that this construction program will cost approximately ten million dollars. The financing has not been firmed up at this time. It is anticipated that the entire program might be handled by one of the following methods or, perhaps, a combination:

1) Bond issue. This would be a City-wide bond issue for construction of complete storm drain facilities. 2) Establishment of drainage districts. By this method, drainage districts would be established and future land developers would be affixed proportionate shares. As the City at the present time is approximately 60% developed, it is obvious that this would not provide 100% financing.

It is apparent that if the City is to construct the full scale program, a bond issue would provide the most clear-cut solution. — Charles R. Handy, Dir. P. W. and City Engr.

Modesto, Calif.—Current storm drainage projects proposed for construction this year will be financed through assessment district proceedings. The parcels within the watershed are assessed on an area basis. The practice has been to assess for sanitary sewers on an area basis, but only to a lot depth of 150 feet.

This community does not have the hill and valley problem; however, the high ends of blocks are assessed the same as the low spots.

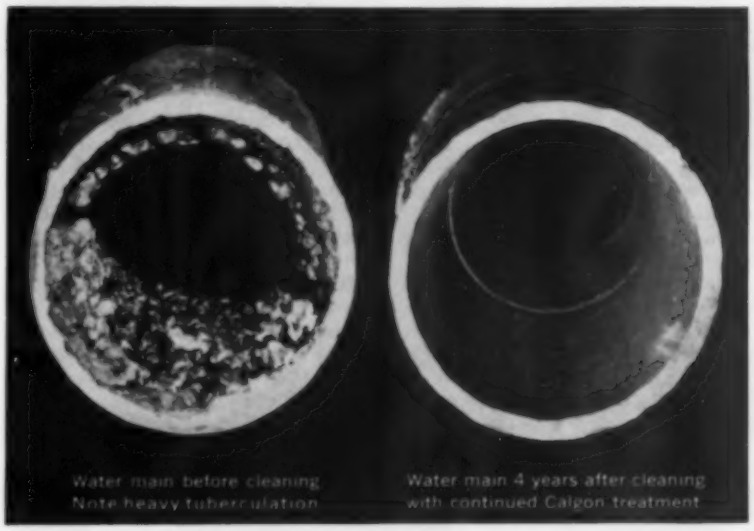
Private properties are not required to connect to storm sewers. They may discharge storm water into the street but through the sidewalk area the runoff must be piped. —L. A. McFarland, Asst. to P. W. Director.

Mountain View, Calif.—We finance a large percentage of our storm drainage systems by assessment. The assessment is based upon gross area and divided into zones of first order benefit, second order benefits, etc. The city contributes 30%. On sanitary sewers, we base the assessment on area and front footage, the area again being divided into zones of decreasing benefits depending upon the distance from the main.—A. M. McKennan, Dir. Public Works.

San Francisco, Calif.—The sewerage system is almost entirely a combined system and the answers to your questions are based on this

CALGON KEEPS FLOW RATES CONSTANT AFTER MAIN CLEANING

in 4-Year Portland Water District Test



Water main before cleaning
Note heavy tuberculation

Water main 4 years after cleaning
with continued Calgon treatment

Part of the Portland, Maine, Water District System supplies Sebago Lake water to Gorham Village. An 11,000-foot, 8-inch main was the main feed between a booster station and a standpipe at the far end. This main had not been cleaned for 20 years, and it was found that the flow coefficient "C" had dropped to between 50 and 56 due to massive tuberculation.

Replacement or reinforcement of this main would be expensive, so it was decided to try cleaning a 4,030-foot section of the main, and use this as a test section to determine the effectiveness of chemical treatment to retard corrosion. Calgon® and Calgon® Composition TG were chosen for this test.

HERE ARE THE RESULTS:

Pipe line coefficient, raised from 56 to 120 by cleaning, *has remained at this level for four years with Calgon and Composition TG treatment.*

No red water complaints.

Labor and chemical costs, in relation to replacement or reinforcement of the main, *have been minor.*

A complete description of this carefully controlled test, with prescribed dosages and methods, is available—ask for Reprint No. 420-12-6. For information on how Calgon chemicals and Calgon know-how can help you, write or phone:

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fact. For storm or combined sewers, trunk sewers are generally financed by bond issue and lateral sewers generally by assessment. If by assessment, the charge to owners is on a linear foot basis. Theoretically there is no difference in benefit between property on a hill and that at lower levels in a valley. In practice, the increased size of sewers required at the lower end of a system frequently results in higher assessments against properties fronting thereon, although we take every available opportunity to equalize the assessments.—Clifford J. Geertz, City Engr.

San Jose, Calif.—Financing is mainly by general obligation bonds and by collection of obligation fees from developers; in a few instances it is by assessment. Benefits for storm sewers are measured on the basis of area and whether the zoning is residential, commercial or industrial. Benefits for sanitary sewers are determined on the basis of front footage and the number of connections along that front footage. Except for commercial and industrial properties that front on a storm sewer line, property owners are not required to connect to storm sewers. —H. J. Flannery, City Engineer.

Santa Ana, Calif.—The City, generally speaking, does the majority of the storm drain work by capital outlay, the funds coming from general taxes. The benefit to the property is measured by acreage. The benefits for storm drains are based on acreage and for sanitary sewers are based on frontage. The city has no hills or valleys, thus all assessments apply the same against all properties. Private property owners are not required to connect to storm sewers unless they fall within their subdivision map area. Private individuals can dispose of storm water into the streets.—Hugh H. Foreman, Dir. Public Works.

Denver, Colo.—Storm sewers in Denver are financed by local public improvement bonds assessable against the property benefited. Benefits are established by an expert or a group of experts in real estate values. These persons determine the increment of value accruing to the properties affected by the proposed storm sewer installation. The increment of benefit for a property on a hill is generally less percentage-wise but the valuation is generally higher so that the end result is an approach to equal assessment money-wise.

Sanitary sewer benefits are determined in a similar manner except that the determination is made by the City. Generally speaking, all square footage property within a sanitary sewer district is assessed the same amount without reference to its location in the district.

Private properties may connect to storm sewers but are not required to do so. As a result, discharge onto the street is permitted. — C. E. Harness, City Engineer.

Miami, Fla.—We finance storm sewers by the assessment method. That is, the areas are subdivided into drainage districts and the benefited property owners are assessed two-thirds of the cost of the project on a square foot basis. The City-at-large pays one-third of the cost. We do not differentiate between property on a hill and property in a valley. Private properties are not required to connect to the storm sewer; they may discharge storm water into the street.

We use a different method for determining the assessment for sanitary sewers. Sanitary sewers are assessed on a front foot basis with the property owner paying for his portion of the cost of installing an 8-inch sanitary sewer at an average

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of four to six-foot cut, plus the cost of the lateral. Pump stations, force mains and trunk mains are paid for by the City-at-large. — Arthur Darlow, Director, Dept. of Engineering.

Pensacola, Fla.—The City finances storm sewers through a bond issue for public improvement certificates. This bond issue is backed by pledging revenue from other sources. We do not assess any of the property owners for storm sewers. However, it is felt that if assessment ever would come about, all of the property owners within a particular drainage area would be assessed equally. It would seem fair to assess them on the basis of area rather than frontage inasmuch as the amount contributed by each property owner is pretty much in a direct relationship to the amount of property he owns.

In certain parts of the city, sanitary sewers are not being assessed against the property owners, but in newly annexed areas the sanitary sewers are assessed against the property owners. This is being done by calculating as rapidly as possible the cost of constructing the sewers where they will be needed and assessing each property owner one-half of their cost on a front-foot basis. Private properties are not required to connect to the storm sewers, except business concerns must connect downspouts to the storm sewer system in the business area of the city, and certain air conditioning waters must go into the storm sewers in the business part of the city. Future storm sewers are being planned by the City of Pensacola, and will be designed by the City Engineering Department. — Paul T. Matthes, City Engineer.

Atlanta, Ga.—This city finances its storm sewers from general funds. This means that relatively small amounts are expended on storm sewers by the City. The City requires the developers of subdivisions within the City limits to install all storm sewers deemed necessary for the development of the subdivisions at the expense of the developer. The City also requires a note on these plats relieving the City of liability for further extensions at a later date.

In the older sections of the City developed before the present regulations went into effect in 1952, the City co-operates with the owners of the property to the extent of furnishing labor and materials to

(*Please turn to page* 203)

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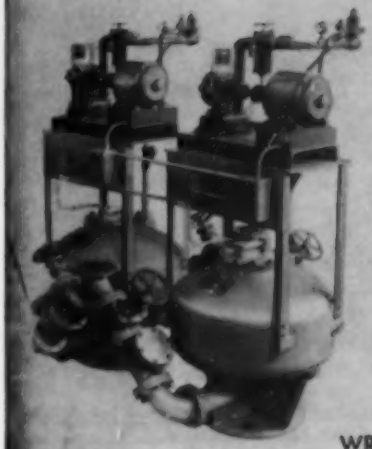

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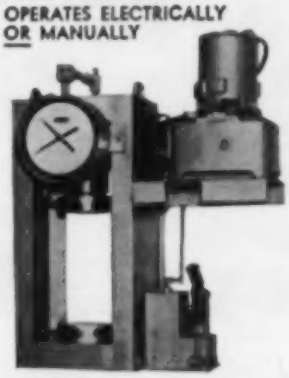

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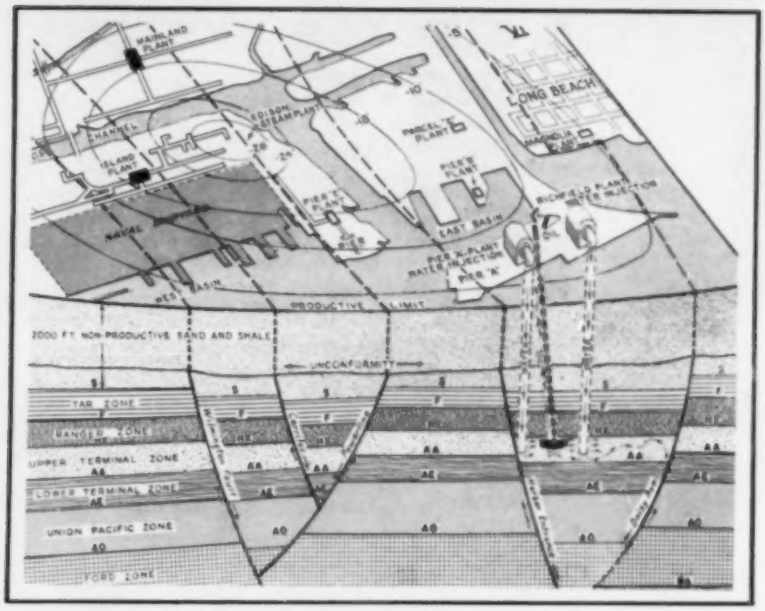

ARTIST'S conception of Long Beach Harbor, demonstrating how the City of Long Beach, Calif., and the producers of the Wilmington oil field are united to stop land sinkage in the Wilmington oil field and adjacent areas. A 20-square mile area has subsided from 2 to 26 feet. The maximum sinkage of 26 feet occurs at the center (Edison Steam Plant). Sinkage of 3 to 5 feet has been recorded in downtown Long Beach (upper right). Surface manifestations of the movement are broken pipelines, disrupted sewer and storm drain lines, sudden buckling of railroad tracks, disturbances in pavements, building cracks, etc. It has been necessary to shorten, re-plumb, and jack bridge structures and to cut sections from building and wharf structures to relieve stress.

Water injection is being used to repressure the oil field; it is hoped that this will arrest or ameliorate subsidence and will also increase the ultimate recovery of oil. The principle of water injection is demonstrated at Pier "A" (right center).

As shown above, the Wilmington oil field, due to its numerous fault blocks, actually is several oil fields in one. Thus a mammoth water injection program is required. It is planned this will eventually reach a combined daily water injection schedule of one million barrels (42 million gallons). The two new water injection plants (Mainland, upper left) and (Island, left center) bring the present daily water plant injection capacity to 874,000 barrels (36.7 million gallons).

Salt water for injection is being obtained from shallow source wells, 150 to 400 feet deep, the water being generally free of bacteria and oxygen. This water is de-sanded and treated to inhibit corrosion. The greatest volumes of water are being injected into the aquifers surrounding the oil pools (lower part of drawing) at pressures up to 2,000 psi. Relatively minor volumes of water are also being injected directly into the oil bearing formations of Tar and Ranger zones (lower part of drawing) as pattern or line flooding. The injected water drives the oil ahead of it toward the wells through which it is produced and fills the voids in the reservoir rock previously occupied by the oil. In this way more oil is produced and pressures in the reservoir rock are increased simultaneously, giving dual benefits.

• • •

Fixed Capital Water Investment

In Wyandotte, Mich., the fixed capital investment of the water department amounted to $86.43 per capita served; the operating revenue in 1958 was $7.06 per capita; and the net operating revenue per capita was $1.16, giving an operating ratio was 83.68 percent.

TRANSIT UNIT USES REFLECTIVE SAFETY LINES

WHERE pavement markings take severe beatings—at off-street bus-trolley turnarounds, on-street steering lines, bus refueling stations, and berthing stalls—the Chicago Transit Authority has installed markings of Catatherm reflective thermoplastic. CTA purchased the thermoplastic on a competitive bid basis and contracted with the manufacturer, Cataphote Corporation, to apply it at seven off-street terminals, six street intersections, two fueling stations and the Chicago Museum of Science and Industry. White was used primarily for steering lines and yellow for stop lines. The job involved using a total of 2,659 ft. of 6-in. white and 2,074 ft. of 6-in. yellow markings. It dries almost instantly to reduce immediate traffic delay.

Financing Storm Sewers

(*Continued from page* 201)

install the necessary storm sewer lines where the owners purchase the pipe.

Private properties are required to install storm sewers where they are deemed necessary in new subdivisions, but small amounts of storm water may be discharged into the sewers, governing requirements for this being the amount of water to be handled. The City is not planning a complete storm sewer system at this time.—R. W. Respess, Engineer of Sewers.

Coeur D'Alene, Idaho — Storm sewers are financed either through general obligation bonds or from the general tax levy. We have had no need for figuring benefits to property owners. By using the methods indicated for financing, it is obvious that benefits must be considered on the basis of community obligation to the citizens as a whole. Private parties are required to connect to the storm sewer in commercial and industrial areas (also institutions). Residential property owners are not required to connect. —L. D. Brownson, City Engr.

Charles City, Iowa—Storm drainage is financed by both special assessments and general obligation bonds. The basis for assessments are area, front-footage and enhanced valuation. The benefits of storm drainage in the past have been considered equal for property on a hill or in a valley. In some cases connections to storm sewers have been required.—Thomas Doyle, City Engineer.

Lawrence, Kans. — Our storm sewer systems are paid for by the city at large; bonds are sold and, in turn, the bonds are paid for by taxes. Our sanitary sewers are financed through assessments. The only private properties required to connect to storm sewers are service stations, in which case the drainage from the wash racks must be connected to the storm system. Any drainage from private properties may drain into the streets. We will build storm sewers in conjunction with our street paving. Only part of the system has been designed as of this date; the design was done by this office.—George J. Williams, City Engineer.

Russell, Kans.—The City of Russell has very few storm sewers but the ones we have are paid for by general obligations bonds. Privately owned properties are not required

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to connect to storm sewers because storm water may be discharged into the street.—Marvin E. Simonton, City Engineer.

Portland, Me.—The City at the present time is served mainly by combined sewers in which both the storm water and sanitary sewage are conducted away in one pipe. Therefore, the question of financing storm sewers has not been a problem. However, there is an area within the City which, when it is developed, will require storm sewers and sanitary sewers as separate lines. When the time comes to construct these sewers the City will be required to answer questions similar to those in your questionnaire. As a start toward these answers, the City Manager has drawn up a resolution to be presented to the City Council for the discussion and action, recommending that:

1) Two-thirds of the cost of constructing sanitary sewers be assessed against the benefited land. 2) One-half the cost of constructing storm sewers, with their catch basins and appurtenances, be assessed against the benefited land. 3) Whenever separate sanitary and storm sewers are required, they shall be constructed and the assessments levied at the same time. 4) Whenever separate sanitary and storm sewers have been constructed, no connection shall be permitted to either sewer until the assessment, estimated or actual, has been paid for both sewers.—Bryan O. Whitney, Commissioner of Public Works.

West Springfield, Mass.—Storm sewers are constructed from funds voted by the annual town meeting in March of each year. We have never built any drains under the Betterment Act, although we have the authority to do so. Since 1953 we have been constructing service extensions on sewers and sewer mains under Betterments. Betterment cost is as follows: $0.75 per front foot of property plus $0.0075 per square foot of area to a depth of 100 feet parallel to the street line. The Health Department requires all home-owners to connect subsurface drains into the drainage system if a drain is located in the street in front of their property and at such a depth as to serve the house or building. No water may be shed upon an accepted street.—Wallace W. Wyman, Town Engineer.

Charlotte, Mich.—The city at large pays for trunkline storm sewers and 2/3 of the cost of a 12" storm sewer is assessed against abutting properties. On sanitary sewers the 2/3 of cost of an 8" sewer is assessed against the abutting properties.—Carl L. Paine, City Superintendent.

Cadillac, Mich.—Storm sewers are financed by special assessment and G. O. Bonds. Generally, the city pays one-half the total cost. Usually it works out that half the cost will take care of a trunk which is in a street not a part of the special assessment district.

On benefits if, for example, property owners on two blocks (2 x 700') petition for paving, the storm sewer required for the complete drainage of the street (1400') is charged to all owners on a front foot basis regardless of the location of the properties. The owner at the top of the hill will pay as much per foot as the owner of the low point. If storm drainage becomes a large area problem, the city will make a G.O. bond issue of it.

Sanitary sewer (laterals) are paid 100% by owners. City pays 1/6 of trunk sanitary sewers.—P. H. Jones, City Engineer.

Detroit, Mich.—The City has a combined sewer system with the ex-

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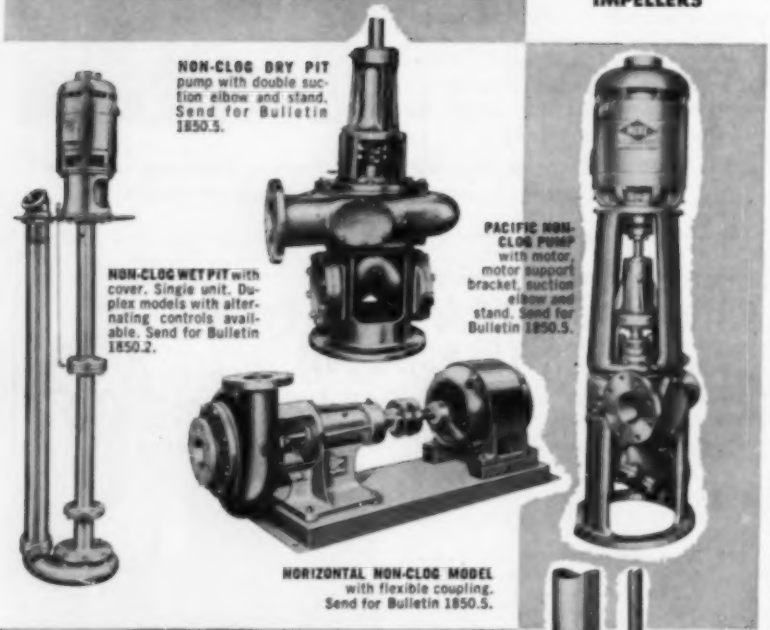

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ception of a small area on the east side of the City. The dry-weather sanitary flow is diverted to sanitary interceptors which roughly parallel the Detroit River and the Rouge River. The sanitary interceptors are considered part of the sewage disposal system. The large combined sewers which serve as our storm sewers are financed by general obligation bonds. The bond issues must be approved by vote of the people and are financed and paid for from the general tax fund.

Private property is served by lateral sewers which are connected into the public sewer system. These lateral sewers, carrying combined flow, are paid for by the benefited property. The basis of the financing is by an area assessment. In those instances where property can be directly connected to a public sewer without the necessity of constructing a lateral sewer, a charge equivalent to an area assessment is made based upon the size of the connection.

The entire sewage treatment system, including the large sanitary interceptors, regulators and diversion works, is financed by Revenue Bonds, which bonds are paid for from the charges for sewage treatment added to the water bill.

Private property is required to connect into a public sewer if the sewer is adjacent to the property. Detroit at present can be considered to be 100% sewered, insofar as private property is concerned, and both sanitary and storm water must be discharged into the combined system. Storm water may not be discharged into the street.

The City of Detroit has made extensive relief additions to its sewer system since the end of World War II, and we plan to continue to spend about $10 million per year until the entire city is served by a system that can handle the run-off from a ten-year storm.—M. F. Wagnitz, City Engr.

Menominee, Mich.—Storm sewers are financed by general obligation bonds. Sanitary sewers are assessed against the benefiting property owners with the city absorbing 25% of the cost. Private properties are not required to connect to a storm sewer. They may discharge storm water into the street if they so desire. We have at present plans to service the remainder of the city with storm sewers.—Donald K. Holland, City Engr.

Niles, Mich.—Storm sewers are financed wtih General Fund tax moneys and with State Highway Department receipts in connection with street improvements. Sanitary sewers are financed on a front footage assessment basis rather than on a strictly benefit basis. Storm sewers are not assessed against property owners.—Wm. E. Korbitz, City Engr.

Comments from city engineering personnel will be continued in the April issue.

• • •

Garbage Weight and Cover Data

According to the annual report of the Department of Public Works of San Francisco, the average weight of garbage was 361 pounds per cubic yard. In fill operations, 0.87 cu. yd. of cover material was required for each ton of garbage and refuse.

• • •

Sewerage at Beach Resort

(*Continued from page* 105)

tained in active service throughout the year, to provide the ultimate in sludge reduction by digestion. The second tank will be maintained full of liquid which will be displaced during the summer months by digested sludge from the active tank.

Operation and Control

Aside from the numerous fresh air intakes, flush access doors and vent pipes, pumping and control building and upper portion of the new digesters, all the treatment facilities are under the boardwalk and adjacent park areas.

The pumping and control building houses on the ground floor the pump control room with laboratory, chlorine storage room, generator-control room, chlorinator room and wash room. In the basement are the grit chambers, Barminutors, pump suction wells, heater room, north and south galleries and the effluent pump room. In the sub-basement are the raw sewage pumps and emergency flood pump.

The sludge operations building provides a general storage room, heater and control room, and gas meter room, all on the ground level and sludge pump and pipe gallery in the basement.

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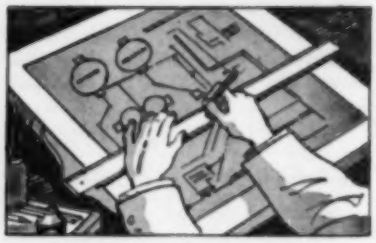

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• • •

County Sanitary Landfill

(*Continued from page* 126)

a dozer was bunching all material in the open pit dump for burning. After about three days, when the rat population was at its hungriest, the health department poisoned the area. The result appeared to be a 100 percent kill, with dead rats lying around by the hundreds. Soil removed from the trench construction was then hauled over the bunched material until all was covered.

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Our supervisor of the dump is furnished with an 8′ x 10′ building to protect him from the weather. He is allowed to salvage what material he can with salable value. He is not allowed to keep it piled in the dump area, but must remove it immediately for we found that his collection of salable junk also harbored a good many rats. He delivers the salvaged material to a local junk dealer who ships it out weekly.

However, we have three problems as yet unsolved. Garbage is picked up by a local contractor for those who wish to sign with his service. Those who do not, deliver their refuse individually. It is essential that our area form a garbage district soon, so that we can enforce disposal through a single pickup source under county franchise and can control dumping. This will give us a greater measure of control in the filling of our trench.

Secondly, our garbage disposal is financed through the current expense funds, of which there is never a sufficient amount to do a complete job. At the present writing, the road department has advanced the funds for this emergency measure, with a complete billing against the garbage fund to be paid at next budget issue. However, we need the establishment of certain rates for the use of the dump, based upon the size and character of load to be dumped, as part of the means of financing the system.

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PUBLIC WORKS

EQUIPMENT NEWS

The Commando with the Hydra-Hammer, one of several hydraulic tools available.

Mobile Power Package

The new Ottawa Commando is a basic prime mover which provides the following: Truck, power crane, aerial tower, fork lift, tractor, bulldozer, snow plow, breaker, etc. It is 2 or 4-wheel steer and 2 or 4-wheel drive. Speeds are up to 35 mph. It turns in a 24-ft. circle. Weight is 9200 lbs. As a backhoe, it will dig 12½ ft. deep in any position of a 190° swing. A folder is available showing the application and use of the Commando with a variety of matched tools.

Ottawa Steel Division, Young Spring & Wire Corp., Ottawa, Kans.

Circle No. 3-1 on the convenient reply card facing page 38.

High Loader

Safety and visibility are features.

The new Lull 1½-cu. yd. loader has an extremely high dumping height of 10'6", enabling the operator to fill completely any dump body from one side of the truck without pushing the material to the far side and refilling the near side. With its design and weight distribution this loader does not require any ballast whether digging or carrying a full bucket. Designed with a very low front silhouette, the bucket is clearly visible to the operator in all positions. The unit is also equipped with two seats to accommodate a trainee or passenger, and an enclosed cab is available when needed.

Lull Engineering Co., 3045 Highway 13, St. Paul 11, Minn.

Circle No. 3-2 on the convenient reply card facing page 38.

Tractor Shovel

A 1 5/8-yard capacity tractor-shovel has been added by N. P. Nelson. Known as the Model 150, it features Nelson underslung arms with 100% operator visibility and safety; 40° tipback bucket at ground level; maximum dumping height under bucket edge 9'0"; forward reach at 7' dumping height 5'2". There are 3 speeds forward and reverse. Weight of gas model is 15,700 lbs.; of diesel 15,900 lbs.

N. P. Nelson Iron Works, Inc., 850 Bloomfield Ave., Clifton, N. J.

Circle No. 3-3 on the convenient reply card facing page 38.

Road Rake

Improvements are in caster mounts (A), hitch (B), scarifier (C), caster adjustment (D), grader adjustment (E).

An improved York rake has been announced. A major user advantage in the new Model RE is the new wheel mounting. Brackets are designed to permit caster wheels to be mounted either ahead of or behind the rake teeth. Rear mounting of wheels is recommended for faster grading of rough terrain; front mounting is for finished raking jobs where elimination of wheel marks is imperative. Rear mounting allows the rake to be used in any angle position.

York Modern Corp., Unadilla, N. Y.

Circle No. 3-4 on the convenient reply card facing page 38.

Designs available for many variables.

Transmitters

New pneumatic indicating transmitters for pressure, flow, temperature, liquid level, differential pressure, and dew point have been introduced by Foxboro. These feature measuring elements which are specifically designed for each major process variable. The transmitter is available with measuring elements in the following range: Pressure—0-10 inches water to 0-80,000 psi; temperature — -450F to +1000F (-270C to +500C); flow (differential pressure)—0-1 to 0-400 inches water; liquid level—open vessels 0-10 inches water minimum; closed vessels 0-20 inches water minimum; dew point —50F to +165F; output signal— 3-15 psi, (3-27 psi optional). Operation is on a 20-psi air supply. Overall calibrated accuracy of the transmitter, including measurement and output signal, is guaranteed to be within ±1/2 percent.

The Foxboro Co., Foxboro, Mass.

Circle No. 3-5 on the convenient reply card facing page 38.

Masonry Drill

This portable masonry drill will, it is claimed, drill holes through the hardest masonry, at any angle, and at a high speed. Holes may be any diameter up to 6¼ ins. and rates are up to 6 ins. per minute, depending on the hardness of the material being drilled, but normally 1 or 2 ins. per minute. Weight is only 175 pounds. Universal electric motor driven, the drill uses diamond core bits.

Kor-It Co., Inc., 991 Richard Ave., Santa Clara, Calif.

Circle No. 3-6 on the convenient reply card facing page 38.

Flocculant

Purifloc N17 is a synthetic high purity flocculant produced especially for use in the treatment of potable water. Recently cleared for use in potable water by the Public Health Service, Purifloc N17 is described as a "synthetic, high molecular weight flocculant with high activity for many types of suspended solids normally found in natural waters." Suggested applications include use as a primary coagulant for presedimentation in conventional and high rate (sludge-blanket) water treatment plants; as a coagulant aid to enhance the activity of primary flocculants such as alum and ferric sulfate; as a coagulant or coagulant aid in chemical water softening operations to reduce the load of suspended solids to the filters; and as a clarification aid to allow rapid sand filters to operate at double or triple conventional hydraulic rates and yet produce water of equal or better quality. A concentration of 1 mg/L is recommended by Dow Industrial Service as a practical maximum for most applications.

Dow Chemical Co., Chemicals Section, Midland, Mich.

Circle No. 3-7 on the convenient reply card facing page 38.

Underdrains

The Transite perforated underdrain pipe is available in 6 and 8-inch diameters in 10-ft. lengths and in 10 and 12-inch diameters in 13-ft. lengths. Holes are ¼-inch and are spaced 3 ins. longitudinally over approximately half of the pipe circumferences. A mechanically exact plastic coupling assures a tight and flexible joint which is stated to be immune to tuberculation and electrolysis.

Johns-Manville, 22 East 40th St., New York 16, N. Y.

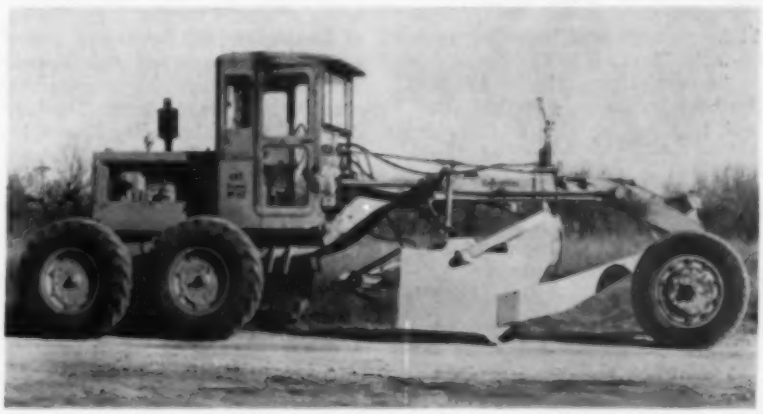
Circle No. 3-8 on the convenient reply card facing page 38.

Scraper for Grader

A new 3½-yard (heaped) scraper unit for mounting on Caterpillar motor graders, is the "Graderscraper". It takes the place of blade and circle on Caterpillar No. 112, 12 and 14 Motor Graders. It utilizes grader power and existing connecting points, permitting fast loading and unloading of most materials. It can be loaded without pushing and once loaded it can be lifted up with the mechanical drive of the grader and carried at full highway speed to the dump areas. Road clearance is 11 inches fully loaded. It can be tilted to one side, to scrape ditch sides while the grader remains level. It can be tilted to either side 17° and can be shifted to either side of the machine to cut six inches outside the grader wheels.

Martin Co., Kewanee, Ill.

Circle No. 3-9 on the convenient reply card facing page 38.



Grader Line

Grader series features models with 83, 100, 125 and 160 hp.

A new series of standard transmission motor graders designated as models 8-D, 9-D, 10-D and 11-D is announced by Huber-Warco Company. The 8-D is powered by an 83 hp International UD-370 engine. Three 100-hp engines are available in the 9-D—the International UD-14A, the General Motors 3-71 and the Cummins J-6-BI. Power for the 10-D can be supplied by either an International UD-554, a General Motors 4-71 or a Cummins NHC-4-BI. Each develops 125 hp. The 11-D, biggest standard transmission grader ever offered by Huber-Warco, is driven by a 160-hp Cummins engine.

There are many design refinements: The turning radius has been reduced by 4 feet. A new front axle design gives an additional 3% lean on the front wheels. All wheels have demountable rims for easier tire changes or rotation. The circle drive is gear driven and has new gear case housings. The moldboard gives better rolling action. The deluxe cab features 18% more visibility, with more safety glass. An efficient hot water heater is available. Optional equipment includes four-wheel brakes on 8-D, 9-D and 10-D (standard on 11-D); rear view mirror; open type cab; electric cab windshield wiper; creeper gears; defrosting fan; directional lights; elevating grader; hour meter; lighting equipment; moldboard extensions—right or left; odometer; scarifier; and snow plow and wing.

Huber-Warco Company, Marion, Ohio.

Circle No. 3-10 on the convenient reply card facing page 38.

Loader Frame

Basic frame permits any combination of loader and backhoe.

A subframe and equipment hydraulic package is now available to mount the new Ford "Super-Duty" loader on Fordson Major Diesel and Fordson Power Major tractors. This enables an industrial user to mount any combination of a Ford "Super-Duty" loader, Ford backhoe, or counterweight boxes on this tractor to fit his job needs. The loader for FMD and FPM tractors is also being made available. This new loader is stated to have a capacity of more than one ton and to supply a need for higher capacity tractor-mounted loading equipment than has previously been available from Ford for FMD and FPM tractors. Lift capacity is 2500 lbs. and breakaway capacity 5500 lbs. Able to lift a capacity load over 11 feet, the new loader can fill any standard size dump truck from one side of the vehicle.

Tractor and Implement Division, Ford Motor Co., Birmingham, Mich.

Circle No. 3-13 on the convenient reply card facing page 38.

Tractors

Two new tractors, a D4 series C, and a D6 series B, have been announced by Caterpillar. The D4, with 65 flywheel hp., has high lugging ability, greater ground clearance and 5 forward and 4 reverse speeds. It develops 13,000 lbs. drawbar pull in first gear with standard transmission. Ground clearance is 14 ins.; gauge may be either 44 or 60-inch. Starting is by gasoline or by 24-volt battery. The D6 has a 93 flywheel hp engine (at 1600 rpm), with high lugging ability. There are 5 forward and 4 reverse speeds. A 15-hp gasoline starting engine is provided on this new D6. When equipped with a dozer, both ends of the blade are visible to the operator. Many other improvements to provide increased efficiency are available on both tractors.

Caterpillar Tractor Co., Peoria, Ill.

Circle No. 3-11 on the convenient reply card facing page 38.

Cranes

Eight carrier mounted cranes and shovels are announced by Quickway. There are three family groups—12½, 10, and 8½-ton in the first group; 20, 18, and 15-ton in the second; and 25 and 22½-ton in the third. All machines are of the same basic design as the 500 20-ton machines now being produced for the Army Corps of Engineers. All figures of crane capacity lift are actual and factual. The three groups have complete capacity coverage from 8½-ton, 3/8-yard to and including 25-ton, 1-yard capacity. There is a "Quick-Way" Carrier for each of the new crane and shovel models, exactly matched to give maximum stability for all types of operation. Either 6 x 4 or 6 x 6 drive may be used, according to the job requirements.

Quickway Truck Shovel Co., Denver 5, Colo.

Circle No. 3-12 on the convenient reply card facing page 38.

Batch Plant

Aeroil has announced a new model portable 6-yard batching plant. This includes a 6-yard weigh hopper of abrasion resistant steel and a 35' long by 18" belt conveyor. It is available with beam scales as standard equipment, and dial scales are optional. Designed to be towed behind a pick-up truck, it has an overall width of 7 ft., a length of 36'6", and a height of 11'6". The plant weighs 6,500 pounds. A unique method of introducing the cement makes the plant easily adaptable for use with either bulk or bag cement.

Aeroil Products Co., Inc., 19 Wesley St., So. Hackensack, N. J.

Circle No. 3-14 on the convenient reply card facing page 38.

Engine coupled to right angle drive.

Angle Drive

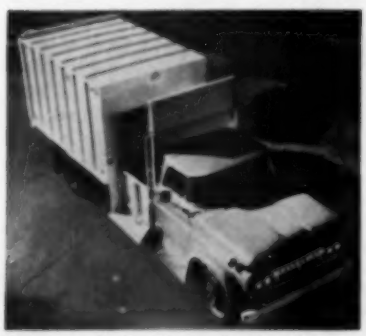
Johnson announces a new automatic combination right angle gear drive, designed for use with dual engine-motor driven vertical pumps in water works, sewage plants and fire protection systems. Called Redi-Torq, it permits testing the engine, from idle to operating speed, without interfering with pumping operations. Any control system where electric power failure initiates engine start will operate the Johnson Redi-Torq. Installation is a simple matter because flexible shafting or couplings can be used between the engine and gear drive; engine clutch is unnecessary. Redi-Torq gear drives are made in sizes from 15 to 200 horsepower, with either solid or hollow shafts.

Johnson Gear & Mfg. Co. Ltd., 8th & Parker, Berkeley 10, Calif.

Circle No. 3-15 on the convenient reply card facing page 38.

Refuse Packer

Notable changes have been made in the 60 Model refuse packer body made by Hobbs Trailer. The advantage of high compression with high capacity, sanitary and safe operation, are retained and in addition, low loading height, a new watertight body, and enclosed cycle control switches are added. There is no leakage of liquids which may be squeezed out of refuse during the compression cycle. Rear doors are designed for an internal packing pressure of 1660 psi (on the deluxe model).



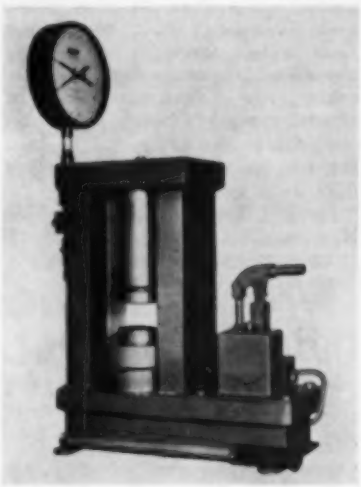
Refuse body has lower loading hopper.

Hyd-Pak Division, Hobbs Trailer Co., 609 N. Main St., Fort Worth, Texas.

Circle No. 3-16 on the convenient reply card facing page 38.

Concrete Tester

Designed specifically for testing small specimens such as 2″ cubes, 3″ x 6″ and 2.8″ x 5.6″ cylinders and concrete pipe cores in compression and soil cement beams in flexure, the New Forney Model M-100 has a loading capacity of 60,000 lbs. and weighs only 240 lbs. completely



equipped. Upper platen assemblies are spherically seated in accordance with ASTM specifications, and there are a variety of standard gages each equipped with snap on connectors.

Forney's Incorporated, Tester Division, Box 310, New Castle, Pa.

Circle No. 3-17 on the convenient reply card facing page 38.

Depth Finder

Reliable subsurface data are made available, without costly drilling, to engineers, architects and contractors by the use of this miniature engineering seismograph. The 16-pound electronic instrument provides complete information for determining precise depth to bedrock, the presence or absence of rock or other solid materials, and gives accurate identification of subsurface materials. Operation requires only two men and the unit can be handled on foot in any type of terrain. Seismic impulses are produced by a sledge hammer. An electronic counter circuit measures the time required for sound waves to travel through the earth to the instrument. Depth and type of material are determined from the instrument readings. Normal depth determinations can be run in 10 to 20 minutes. Generally profiles can be completed at the rate of ¾ mile per day using a station interval of 200 feet.

Geophysical Specialties Co., 15409 Robinwood Dr., Hopkins, Minn.

Circle No. 3-18 on the convenient reply card facing page 38.

Traffic Stripe Remover

The Concut Model PRS 360 is used for removal of traffic paint markings and for cutting grooves necessary for recessed traffic markings into concrete or asphalt pavement. It is also useful for scarifying concrete surfaces, imparting an attractive non-skid, ridged surface. With minor modifications the unit can be used as a concrete saw. At a recent demonstration held in Los Angeles the PRS 360 completely eradicated a portion of a 12-in. traffic marking at a speed of approximately 10 ft. per minute. As a paint remover it makes the removal of tough, hard bonding, thermoplastic paint markings relatively easy.

Concut Sales Inc., 1845 Belcroft Ave., El Monte, Calif.

Circle No. 3-19 on the convenient reply card facing page 38.

Removes paint and scarifies concrete.

Tamper

Tamping force and speed are improved in models with 13-in. to 30-in. plates.

Tamping force has been increased as much as 50% and travel speed as much as 100% in the newest Jay tampers which can compact as much as 100 cubic yards of earth per hour in 6-in. lifts. A new plate contour provides faster, better tamping in heavy soils. The Model J-13 is available with plates in 13", 18" and 24" widths for compacting earth in close quarters. This model is also a blacktop tamper, using a special water plate as an accessory for compacting bituminous concrete. The Model J-18 with plates in 18", 24" and 30" widths, fits the widest range of jobs, areas and soils. Model J-36, with plates in 24", 30" and 36" widths, is a big-area tamper for maximum production.

J. Leukart Machine Co., Inc., Columbus, Ohio.

Circle No. 3-20 on the convenient reply card facing page 38.

Excavator

In this low cost excavating machine, excellent visibility coupled with the short wheel base, enables the driver to get into difficult places. Full swing on the upper mechanism enables the Hydraxcavator to load out in any position. Hydraulic outriggers on rear of chassis permit maximum stability under adverse conditions. Steering, forward and reverse, locking of brakes, and setting of outriggers are all operated from the upper mechanism cab. The standard attachment is the Hydrascope. The boom has a reach of over 20 feet from center of swing with a telescoping action of 7 feet. The end attachment may be rotated 90° either side of center to permit dressing of slopes, etc. A telescoping crane boom and backhoe boom are also available plus numerous end attachments thus adapting the model BR-5 to any crane or excavating task within its capacity range which is ⅜-yard.

Davis Engineering, Inc., Dowagiac, Mich.

Circle No. 3-21 on the convenient reply card facing page 38.

Front Sweeper

This front-mounted sweeper can be mounted on any type tractor, truck, jeep or similar prime mover. A simple mounting bracket is installed easily. Sweeping assembly can be detached by removing one kingpin and disconnecting quick coupling. The sweeper has a hydraulic ram for adjusting the brush to ground pressure. The brush rotates at approximately 150 rpm, entirely independent of the prime mover, angling about 30 degrees right or left. Power is supplied by air-cooled Wisconsin engines. If necessary, the prime mover can be slowed down for heavy accumulations while the brush maintains a constant speed. Brushes of Palmyra fibre or of steel are available.

Little Giant Products, Inc., 1530 N. Adams St., Peoria, Ill.

Circle No. 3-22 on the convenient reply card facing page 38.

Handy Hammer

The Henry hydraulic hammer is a combination breaker and rock drill and will operate from any tractor hydraulic system with a capacity of 10 to 23 gpm. No additional power source is needed. Weighing only 85 pounds, it is easily portable and can be used as an adjunct to a backhoe or a tractor shovel in earth moving operations. Moil points, spades, tampers, drill bits—all standard air hammer tools may be used.

Hydraulic pavement demolition tool.

Henry Manufacturing Co., Inc., Topeka, Kans.

Circle No. 3-23 on the convenient reply card facing page 38.

Sheet Screen

A pierced metal sheet has been introduced by Cross Perforated Metals, National-Standard Company. The sheet, known as Conidure, is made by a special process. Trapezoidal holes are pierced in sheets of carbon steel, stainless steel, copper, brass or aluminum. Sheet thickness can be up to seven times hole diameter. Hole diameters range from 0.004 to 0.099 inch, and sheet thicknesses range from 0.014 to to 0.079 inch. It is available in sheets to 31 ins. wide, or formed into sheared shapes, cones, segments and cylinders. It can be tensioned and made with clamping grooves or turned edges. This sheet has utility in many fields, perhaps including water and waste treatment.

Cross Perforated Metals, National-Standard Co., Carbondale, Pa.

Circle No. 3-24 on the convenient reply card facing page 38.

Wheel Loaders

Major features and product details of the Cat. No. 944 Traxcavator, first of an all-new line of wheel loaders produced by Caterpillar Tractor Co., have been announced. Powered by either a gasoline or diesel engine, the No. 944 is fitted with a 2-yd. bucket as standard equipment. Both engines are rated at 105 net horsepower. High productive ability results from the combination of power shift transmission, which permits split-second shifting into forward or reverse gear; a high capacity hydraulic system that delivers full hydraulic power during critical loading phases; and a high degree of machine stability in all conditions.

Evolved through a research and engineering program, the new wheeled Traxcavator underwent more than 14,000 machine test hours under all operating conditions, both on the company's proving grounds

Machine holds full load while moving.

and on contractor job sites located across the country.

Dumping reach of the new Traxcavator is 31¾" at maximum height; the maximum dumping height is 9' 2". This combination of reach and height permits precise and fast load-spotting when dumping into trucks or other vehicles. Front tires are the farthest-forward portion of the machine frame, eliminating the risk of damage to truck bodies by contact while loading.

For superior load handling, the bucket is provided with a tip-back angle of 41° at ground level; tip-back at maximum lift is 50°. Automatic bucket positioner and lift kickout, operated hydraulically, are standard equipment on the No. 944.

A side dump bucket, similar to that available on track-type Traxcavators, is one attachment offered. Its capacity is 2 cubic yards, same as the standard bucket. The side dump bucket extends 20 inches to the outside of the left front wheel, and allows dumping to the left side with a minimum of machine maneuvering. An extra counterweight group weighing 1000 lbs. for use with the side dump bucket, is installed inside the frame on top of the standard counterweight. A light material bucket has a capacity of 3 yds., and is recommended on the No. 944 for handling material under 2000 lbs. per yd. Its increased capacity is accounted for in increased width, which retains maximum ground clearance under the cutting edge when dumping. A 2-yard quarry bucket is also available. Similar in basic construction to the standard bucket, it has a reinforcing metal plate along the entire underside. Bucket tooth groups, having replaceable tooth tips, are available for the standard bucket.

Caterpillar Tractor Co., Peoria, Ill.

Circle No. 3-25 on the convenient reply card facing page 38.

Brighter Fluorescents

Latest development in fluorescent lighting is the Sylvania "aperture" lamp, which has brought the brightness level of fluorescent tubes to 22,000 foot lamberts. Developed by Sylvania Lighting Products, the lamp has a reflective interior with a 30° clear aperture through which light is emitted. The narrow beam of light is then reflected to the desired area. The new aperture lamp is a key part of Sylvania's Controlled Powerbeam System, which is designed to provide uniform light distribution without glare. These features make the unit particularly well suited for lighting highways, tunnels, bridges and expressway turn-offs. For such applications, the unit is mounted on 3-ft. high standards with the light output directed onto the road at a low angle. The method makes objects stand out more brilliantly and prevents glare from reaching the level of the driver's eyes.

Sylvania Electric Products, Inc., 730 Third Ave., New York 17, N. Y.

Circle No. 3-26 on the convenient reply card facing page 38.

New style fluorescents mounted on 3-ft. standards in turnpike test installation.

OVERHEAD or UNDERGROUND

it's all in a day's work for the HYDROCRANE®

The unusual flexibility of the hydraulically operated HYDROCRANE crane, hoe, or shovel results in a use factor of almost 100% for many utilities and municipalities. For example, a midwest utility used its HYDROCRANE with interchangeable crane and hoe attachments on the following jobs within a span of a few hours.

Assignment: With clamshell attachment, digs 2½'x6'x11'-deep excavation for a sewer connection.

Why the HYDROCRANE? Highly industrialized area with many underground installations to work around. Digging here was too tricky for anything but hand shovels or a HYDROCRANE machine.

Excavation Completed — three hours.

Assignment: While workmen make sewer connection, the crane reports to overhead crew working four miles away. Helps install pole, steel platform and transformer.

Why Use the HYDROCRANE? Hydraulic, fractional-inch control eliminates most manual positioning of heavy equipment.

Installation Completed — one hour.

Assignment: Returns to original location. Helps backfill excavation. Mounted on 2½-ton truck, the HYDROCRANE crane moves nimbly through traffic . . . travels up to 50 mph on the highway.

Let your Bucyrus-Erie distributor show you how this hydraulic crane and hoe will keep busy for you all day — overhead, underground or on the level.

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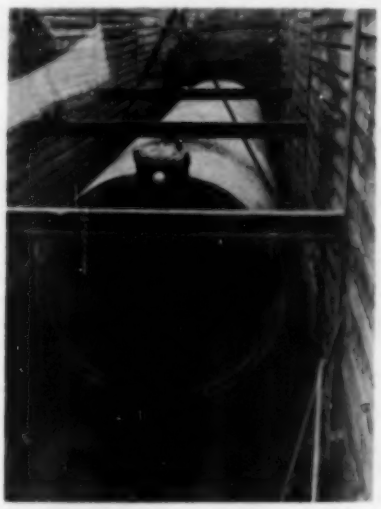
—Worth Seeing

A pictured promise that at last the lowly New York City pedestrian will get a break when snow clogs crosswalks and storm sewer inlets. Lined up in front of the City Hall are 100 International I-460 Utility Tractors, newly purchased by the city's Department of Sanitation. Each is powered by a modified C-221 six-cylinder engine, has a heated cab, Good Roads snow plow and special signal and caution lights.

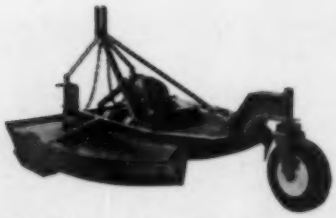
Largest prestressed concrete cylinder pipe in the world is this 120-in. Lock Joint prestressed concrete embedded pipe. It is being installed in the effluent line of Philadelphia's new modern Torresdale Water Treatment Plant.



Lighting for tunnels is demonstrated by this installation of Crouse-Hinds Type HLG fluorescent fixtures in the vehicular tunnel under the Dwight D. Eisenhower lock of the St. Lawrence Seaway at Massena, New York.

Use of aluminum in highway applications is exemplified by the lighting standards, bridge rails, signs and chain link fence of Miami's 36th Street Causeway. Reynolds Metals Co. photo.

The battle against litter bugs is dramatized in Los Angeles with this eye-catching demonstration of new meshed metal baskets. Design was based on public use and preference tests.



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★ Welcome to **Lloyd G. Byrd** as an associate editor of PUBLIC WORKS! With ten years diversified experience in engineering construction and administration in the highway field, most recently with the Ohio Turnpike, we present him as an added asset to our readers and advertisers.

★ Buffalo Meter Co., Buffalo, N. Y., promotes Sales Manager **Herbert F. Barrett** to general sales manager;

Mr. Barrett

Mr. Edwards

Howard L. Edwards becomes sales manager of American Water Meters to water works and public utilities.

★ Food Machinery & Chemical Corp. announces Hydrodynamics Division as a new name for operations in pump manufacturing and allied fields. Under it comes former Peerless Pump and Chicago Pump divisions, but these will retain their identities.

★ Wausau Iron Works (Wis.) takes over manufacturing and sales rights of "Sno-Thro" plows, formerly made by Krause Industries, Baraboo, Wis.

★ **William H. Otis** appointed sales manager, York Modern Corp., Unadilla, N. Y. as part of nationwide expansion for York road rakes.

★ Steel Plate Fabricators Association re-elects officers and directors. These include **Walter B. Van Wart**, president; **E. G. Cole Jr.**, president of R. D. Cole Mfg. Co., Newnan, Ga., vice-president; and **Dr. E. E. Michaels**, president Chicago Bridge & Iron Co., as chairman of the executive committee.

★ **John F. Harrison** is manager, Littleford Brothers' new Compaction Division.

★ **R. A. McQuade** returns to Simplex Valve & Meter Co. Division, Lancaster, Pa., as assistant to the general manager.

★ **David G. Chase** becomes director, sanitary engineering, Texas Vitrified Pipe Co., Mineral Wells, Texas.

★ **Don L. Holmes** adds to his responsibilities as advertising manager, The Flintkote Co., New York, those of manager of the new Product Information Bureau.

★ Deere & Co. announce a new nationwide plan with Boothe Leasing Corp. of San Francisco, which will permit customers to lease Deere tractors and equipment.

★ Portland Cement Association creates by merger a single Paving Bureau under **Gordon K. Ray** at its Chicago general office to provide engineering service and technical information on both concrete and soil-cement pavement.

Mr. Ray

Mr. Nemes

★ **Ted Nemes** is new sales manager, Lighting Standard Div., Kerrigan Iron Works Co., Nashville, Tenn.

★ **John G. Notheis** is named Southern zone manager Daybrook Hydraulic Division, of Bowling Green, Ohio, with special responsibility for dump bodies, power loader and packer equipment in this field.

★ A committee is a group of men who waste hours and keep minutes.

—Houston S'ide Rule

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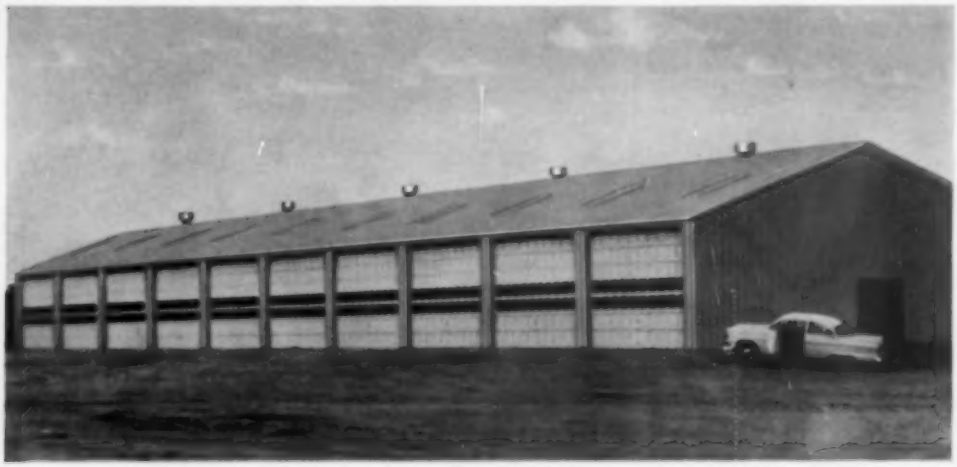

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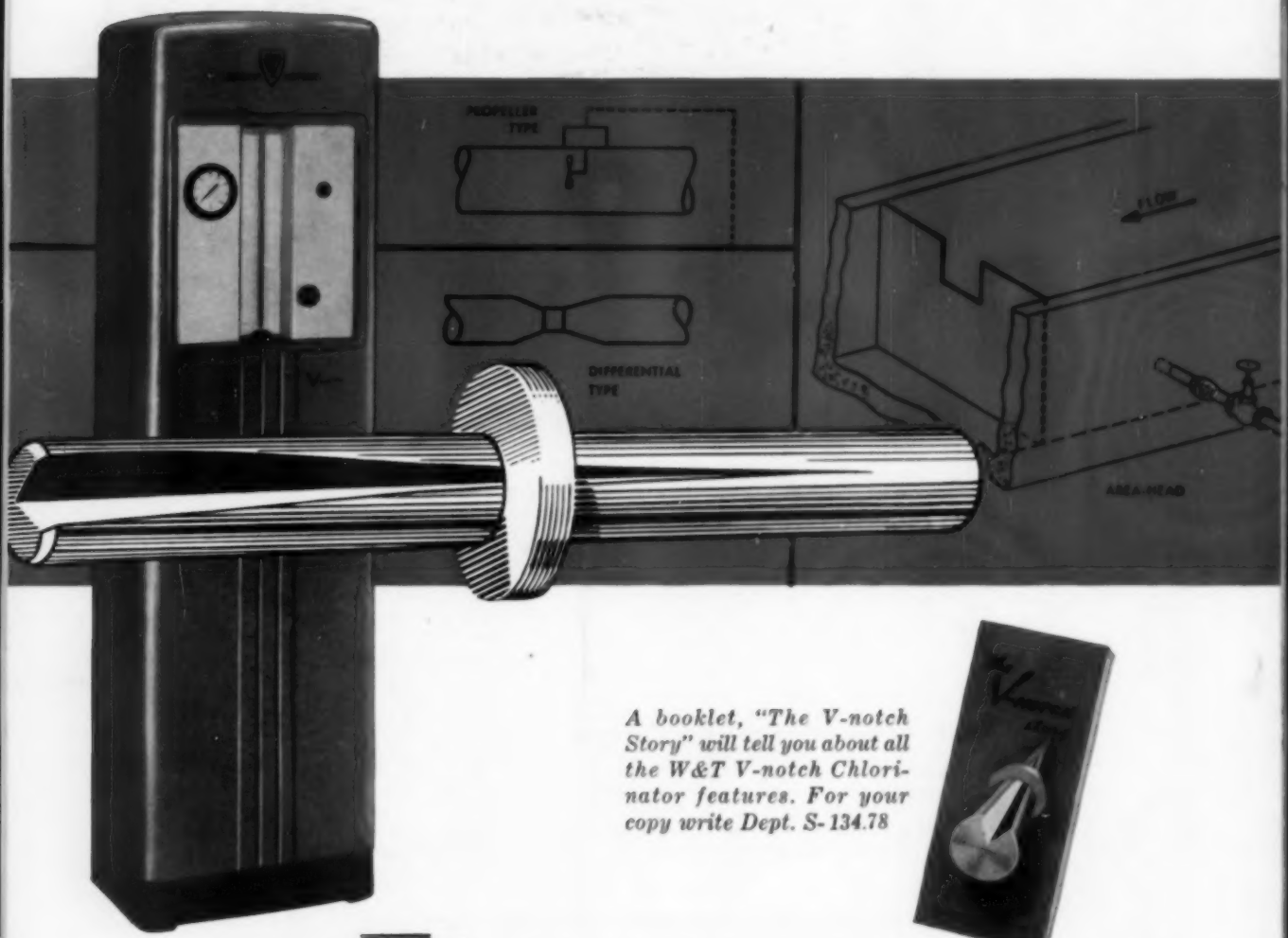

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